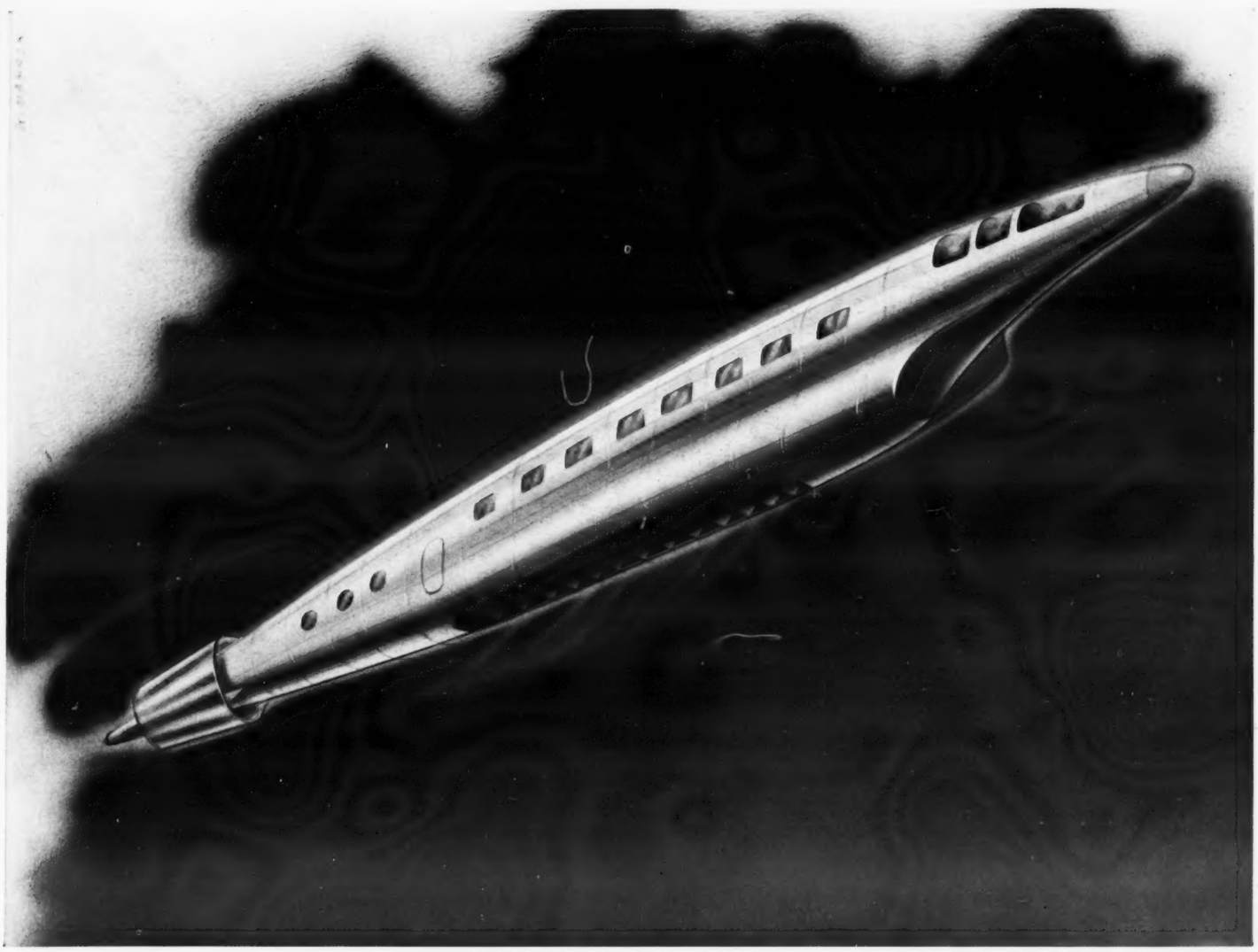
INTERAVIA

REVIEW OF WORLD AVIATION



Price of this Issue —

U.S.A.:	80 cents
British Isles:	3/6
Switzerland:	Fr. 2.80
Netherlands:	Fl. 2.50
Denmark:	Cr. 5.-
Germany:	DM 3.-
France:	Fr. 300
Italy:	Lire 410
Japan:	U.S.$ 0.80
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No 1/1958

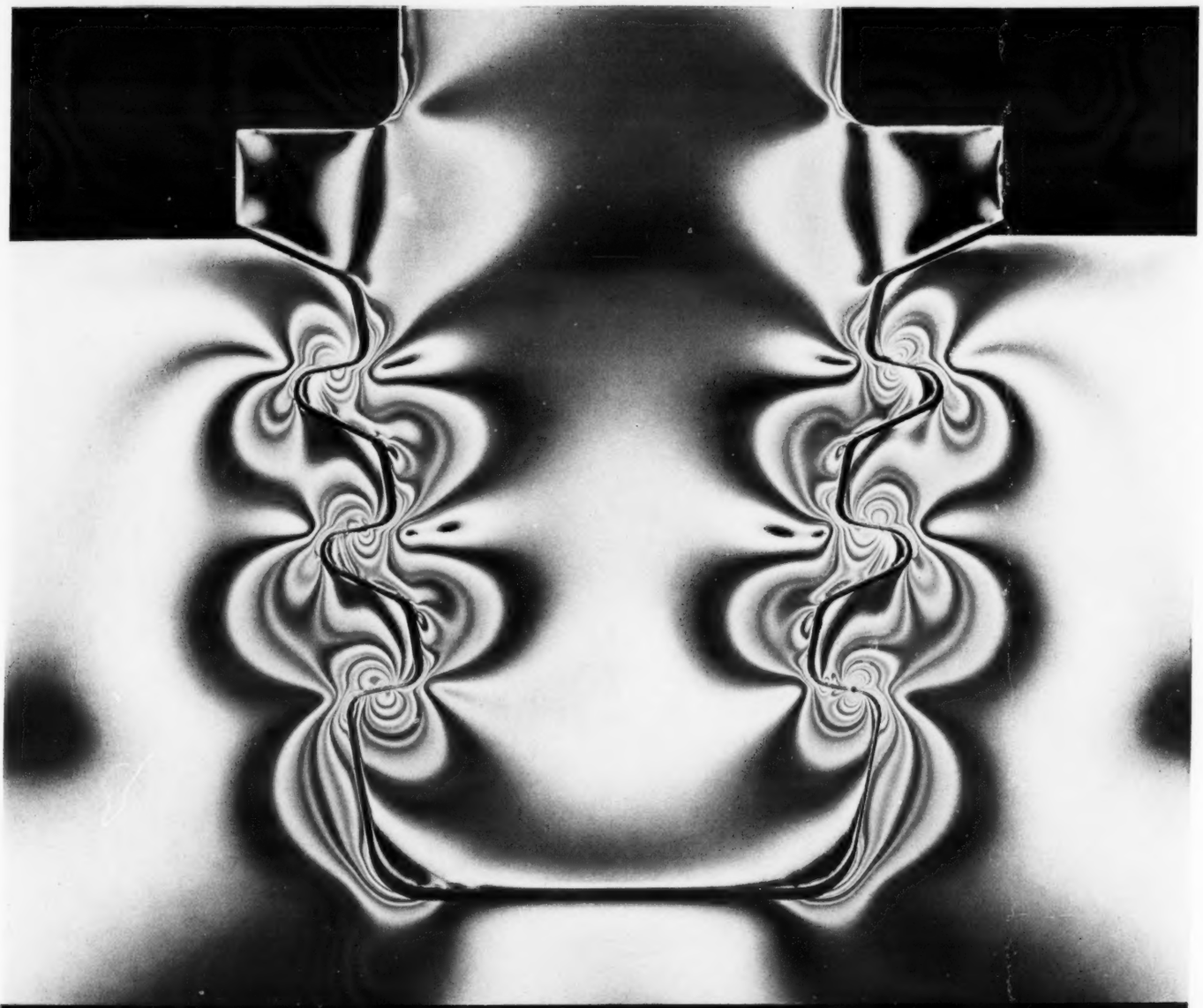

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Illustration shows stress patterns in a jet engine blade root under load, using color photography and photo-elastic stress analysis.

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INTERAVIA

Review of World Aviation

Volume XIII **No. 1** **January 1958**

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FRONT COVER: Wingless supersonic aircraft taking off vertically. (Interavia drawing based on the ideas of Dr. A. Lippisch.)

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Room 21, 1500 Massachusetts Ave., N.W., Washington 5, D.C.
James C. Galloway, 6535 Wilshire Blvd., Los Angeles 48, Calif.

Distributors:

Austria Morawa & Co., Wollzeile 11, Vienna I
Canada Wm. Dawson Subscription Service Ltd., 587 Mount Pleasant Road, Toronto 12, Ont.
Edward Company Regd., P.O. Box 98, Station Delorimier, Montreal P.Q.
Finland Akateeminen Kirjakauppa, Keskuskatu 2, Helsinki
Rautatiekirjakauppa Oy, Köjdenpunojank 2, Helsinki
Germany W. E. Saarbach G.m.b.H., Gertrudenstrasse 30, Cologne
Great Britain W. H. Smith & Son, Ltd., Strand House, Portugal Street, London, W.C. 2
Wymans Ltd., New Street Square, London, E.C. 4
Ireland Basil Clancy, Cooleevin, Foxrock, Co. Dublin
Japan Maruzen Co. Ltd., 6 Tori-Nichome Nihonbashi, Tokyo
Norway A/S Narvesens Litteraturtjeneste, Postboks 115, Oslo
Uruguay Humanitas, Colonia 883, Montevideo

Advertising Department: Publishing and Editorial Offices, Subscription Department: Interavia S. A., 6, Corraterie, Geneva. Telephone: 25 42 34 (five lines). Cables and Telegrams: Interavia-Geneva. Teleprinter: 22 122. Postal Cheque Account: Geneva I 5380.

Annual Subscriptions: U.S.A. and Canada, U.S. $7.00; United Kingdom and Eire, £2.2.0; Commonwealth, £2.6.0; Switzerland, 28.— fr.; Austria, 170.— sch.; Belgium, 320.— fr.; Denmark, 48.— kr.; France, 3000.— fr.; Germany, 30.— DM; Holland, 25.— fl.; Italy, 4060.— L. it.; Japan, U.S. $7.00; Latin American countries, U.S. $7.00; Norway, 50.— kr.; Spain, 360.— pts.; Sweden, 35.— kr. All other countries, 28.— Sw. fr.

Appears Monthly in Four Editions: English, French, Spanish and German.

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Brutal, Conclusive Tests at High Altitudes Reveal Airliners Stop Shorter, Safer with Goodyear Skid Warning Equipment!

Exhaustive tests conducted by Pan American Grace Airways, Inc., have proved the remarkable efficiency of the revolutionary new Skid Warning System* developed by the Goodyear Aviation Products Division.

Equipping first a DC-6B for tests in the United States, and then a DC-7B for grueling high-speed rejected take-offs and landings at Quito, Ecuador, and on difficult runway surfaces in La Paz, Bolivia—located at 9,200′ and 13,404′ above sea level respectively—PANAGRA has made a revealing report of the success of the new Goodyear Skid Warning equipment:

(1) *Not a single tire was blown during the stop tests* which included 32 landings at speeds up to 198 mph on loose rock and sand runway surface.

(2) Incredibly short landing distances were achieved through use of this equipment with runs decreased an average of 16% in the DC-6B test.

As a result, PANAGRA is satisfied it can now receive CAA approval for operating Skid Warning-equipped 7B's on fields located at such extreme altitudes, with a profitable combination of high pay load and minimum runway lengths with proved regularity and safety.

WRITE FOR INFORMATION on the one system that requires no brake modification, can be easily installed on any existing brake or braking system, allows pilot full control of his braking at all times! Address: Goodyear International Corporation, Aviation Products Dept., Akron 16, Ohio, U. S. A., or The Goodyear Tyre & Rubber Company (Great Britain) Ltd., Wolverhampton, England.

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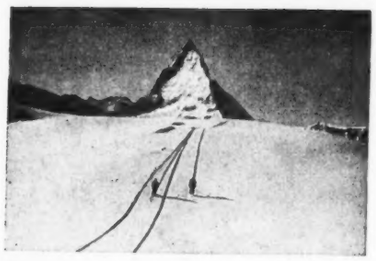
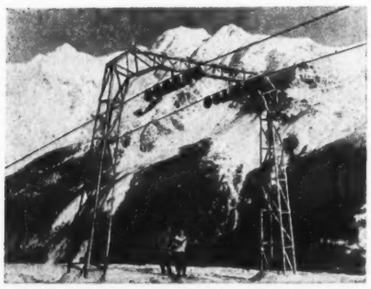
Ready for the Races in the Alpes vaudoises.

Oh boy ! What a view on the Mont-Blanc (highest peak in Europe) and the French Alps. Shot from the Swiss Jura.



Can you imagine how happy these two people feel ? The " Suger cake " is the Matterhorn (Alpes valaisannes).

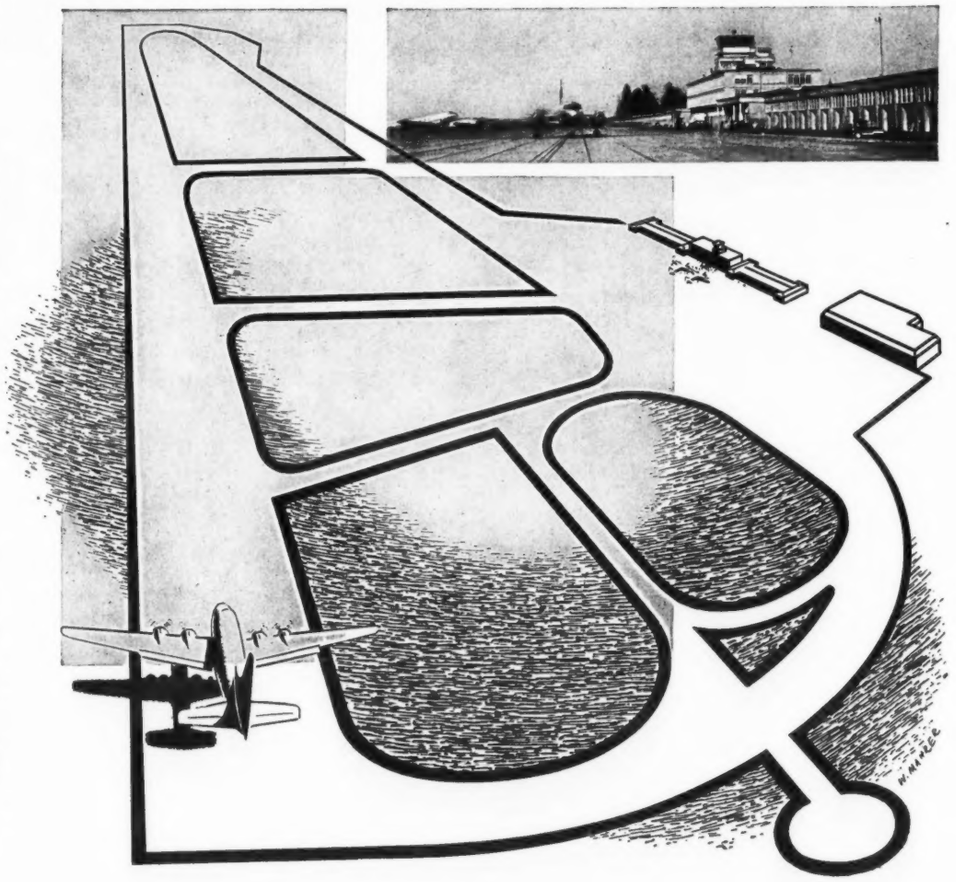
On the sunny side of good old Earth. This train will take you right into the heart of the Jungfrau (Bernese Oberland).



And here is the way to climb a mountain without getting tired. In front of the majestic Mont-Blanc, French Savoy.

GENEVA

INTERNATIONAL AVIATION CENTRE



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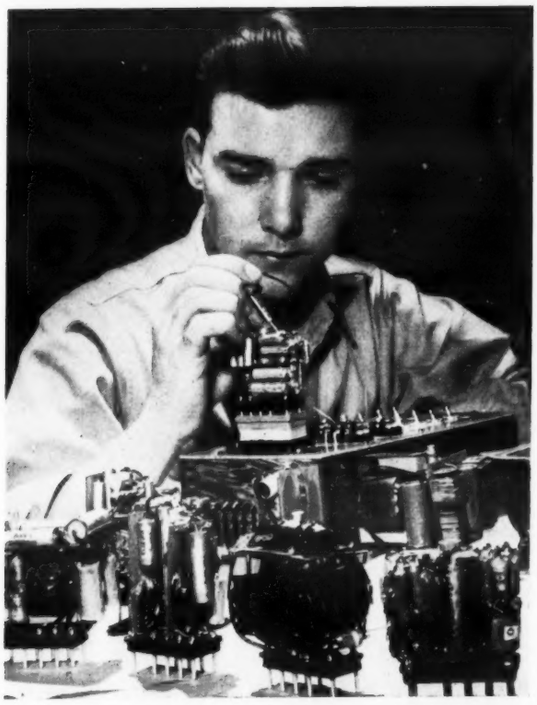
Around the World

J-57 TURBOJETS power the Boeing KC-135 tanker-transport, left, which has shown the potential of the coming generation of large jet airliners by flying 6,350 miles nonstop and without refueling, from the northern U. S. to Buenos Aires. The J-57 jet engines were designed, developed and produced by Pratt & Whitney Aircraft, and are used in many other types of important U.S. military aircraft. JT3 commercial versions of these engines will power the Boeing 720, and many of the Boeing 707 and Douglas DC-8 jet airliners now in production. Other 707s and DC-8s will use Pratt & Whitney Aircraft's JT4 engines, commercial versions of the J-75, most powerful jet engine in quantity production in the free world.

EXPLORING FOR MINERALS is one of many important activities in which helicopters play significant roles. This Sikorsky S-55 carries an electromagnetic detector, a scintillation counter, and a magnetometer. The helicopter can follow closely contours of rough and mountainous terrain in flight patterns that cannot be approached by fixed winged aircraft.

with United Aircraft

AIR-CONDITIONING systems for Convair 880 jet airliners to enter service in 1960 will be made by Hamilton Standard. The cooling unit weighs only 150 pounds yet has a 10-ton output which can be stretched to 12 tons when necessary. By contrast, the air-conditioning unit in one of the latest piston-engine transports weighs over 400 pounds and has only a 7-ton capacity. Each Convair 880 will have two identical systems, operating together or individually. Each is made up of a Freon cooling system, a turbo-compressor, and an electronic temperature control.



ELECTRONIC PRODUCTS are now being designed and manufactured in a separate department at Hamilton Standard. For nearly 40 years the world's leader in propellers, Hamilton Standard ten years ago began a diversification program, specializing in air-conditioning systems, fuel controls, jet engine starter, pumps and valves. These are used in more than 50 types of turbine-powered aircraft and missiles. Now Hamilton Standard is increasing its activity in the electronics field. It will devote its talents to a wide variety of electronic products.

United Aircraft Corporation's manufacturing divisions are the leaders in their chosen fields . . . aircraft engines, propellers and jet aircraft equipment, and helicopters. In commercial and military aviation, products of Pratt & Whitney Aircraft, Hamilton Standard and Sikorsky Aircraft offer advanced design and sound engineering, backed by unsurpassed development, testing, and production facilities.

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12 th · 27 th April 1958

INTERAVIA

Deadline Notes

No. 1, 1958

● **A British-Soviet agreement** for London-Moscow services, to be operated by Aeroflot and B.E.A., was concluded in December following discussions which had been going on in London for some two weeks. It is expected that the aircraft to be employed will be Tu-104s and *Viscounts* and that initial services will be twice weekly via Copenhagen, probably commencing next summer. Much technical work remains to be done before the agreement can come into force.

● **B.O.A.C.'s Bristol Britannia 312** successfully completed its inaugural London-New York flight on December 19th in 12 hours 25 minutes, sometimes against head winds of 100 m.p.h. The London-New York service will operate once weekly in each direction, but B.O.A.C. plans to extend operations to Canada and to other parts of the United States next spring. Later in 1958 the *Britannia* will take over the daily London-New York Monarch service from B.O.A.C.'s *Stratocruisers*.

● **Air-Inter** will not be able to begin operations on domestic routes until the tax on aviation fuel is abolished, the company's President, René Lemaire, said in Paris. The first three services planned are Nice-Marseilles-Toulouse-Bordeaux, seven times a week with DC-3s ; Marseilles-Paris, seven times a week with DC-4s ; and Paris-Strasbourg, seven times a week with DC-3s. Initially, Air-Inter will use aircraft chartered from Air France or private carriers.

● **K.L.M. Royal Dutch Airlines** will increase the frequency of the Amsterdam-Houston services from two to three flights weekly as from January 8th, 1958. Inaugurated on September 3rd, 1957, as a weekly flight, the frequency was increased to twice weekly on October 6th to cope with the rapid development of the service. The flight from Amsterdam to Houston takes 21 hours 45 minutes, and Houston-Amsterdam 18 hours.

● **Canadian Pacific Airlines** plans a new polar route service between Vancouver and London. If approved by the respective governments the service will open on April 1st, 1958, and the single tourist fare will be reduced to $351.

● **United Air Lines Inc.** has announced plans for a fleet of 51 Boeing 720 jet liners by 1965. To date U.A.L. has ordered 11 Boeing 720s with options on a further 19, plus 40 DC-8 long-range jets ; the company now plans to purchase additional 720s in small increments each year until the fleet is complete. U.A.L. President W. M. Patterson has said that the Boeing 720s will be brought into operation in 1960 and will offer services Seattle-San Francisco in 1 hour 40 minutes, and Seattle-Los Angeles in 2 hours 30 minutes. The Boeing 720 will be capable of operation with a full load of 100-152 passengers from any airport now serviced by U.A.L.'s DC-7s.

● **Trans World Airlines** commenced regular scheduled flights to Bangkok and Manila on January 1st, 1958. These services will link 65 United States cities directly with Southeast Asia and the Orient. Passengers for Bangkok and Manila fly with the daily North Atlantic service operated by T.W.A. to England or Continental Europe. From Athens there is a twice-weekly service via the Middle East, India and Ceylon to Bangkok and Manila. Connections are provided at Manila with Northwest Orient Airlines' Far East and trans-Pacific services.

● **VARIG's three Boeing 707** jet transports will be powered by Rolls-Royce *Conway* engines, it has now been confirmed. The company will operate these aircraft on the non-stop New York-Rio de Janeiro service.

● **Japan Air Lines'** procurement programme calls for a total of four DC-7Cs, five DC-6Bs, and ten C-54 *Skymasters* by April 1958 ; delivery of four DC-8s is scheduled for 1960.

● **A Burmese aviation delegation,** headed by U Tin Thein is in Djakarta for negotiations with the Indonesian Government on the question of opening services between Rangoon and Djakarta. Agency reports indicate that once-weekly flights between Rangoon and Djakarta will possibly commence in January 1958.

● **I.A.T.A. membership :** Quebecair Inc. has been admitted to Associate membership in the International Air Transport Association. This brings the total number of member airlines to 81.

● **Tunisia joins I.C.A.O. :** Tunisia on December 18th became the 72nd member State of the International Civil Aviation Organization, thirty days after its instrument of adherence to the Convention on International Civil Aviation was deposited.

● **Interceptor project :** The organizational proposal submitted by Heinkel, Messerschmitt and Bölkow for the joint development of an interceptor aircraft has been accepted by Defence

Minister Strauss and Lieutenant General Kammhuber. The three firms will now set up a joint undertaking, and results obtained from development work carried out on behalf of the Defence Ministry will remain the property of the undertaking ; the firms will maintain their individual production independence.

● **A Fokker Friendship** arrived in New Delhi on December 10th for demonstrations in India on the first leg of a tour including Pakistan, Kuwait, Saudi Arabia, Iraq, the Lebanon, Egypt and Italy. The aircraft was demonstrated to Hindustan Aircraft Ltd., Bangalore, on December 13th. The Indian authorities are reported to have shown great interest in the aircraft, and according to unconfirmed reports from Bombay, the *Friendship* may be manufactured by H.A.L. under licence in India. The aircraft returns to Holland in January.

● **Aeronautica Macchi,** Varese, has recently signed an agreement with German Bianco S.A. of Buenos Aires for large-scale production of the Aer Macchi MB.308 in Argentina. Aeronautica Macchi will supply components for the first 100 aircraft for assembly by German Bianco, but subsequent aircraft will be manufactured entirely in Argentina.

● **Société Boisavia** has concluded an agreement with Société Brissoneau-Lotz whereby the latter will manufacture a batch of *Mercurey* four-place aircraft at its Creil factory. Starting in February, one *Mercurey* per week will come off the new production line. It is also possible that the *Anjou* twin-engine executive aircraft will be built by Brissoneau-Lotz. Boisavia will in future devote itself entirely to prototype construction.

● **Lockheed Aircraft Corp.** has been awarded a $100,000,000 U.S.A.F. contract for 53 C-130B *Hercules* combat transports. First deliveries for the Air Force are scheduled for December 1958.

● **The Avro CF-105** has gone into production, and orders have been placed with subcontractors for components for a total of 40 aircraft ; this figure includes an initial test batch of six aircraft already on order. The total value of the whole project will be approximately $300,000,000. This decision marks the end of a long controversy over the Avro *Arrow* : the R.C.A.F. wanted the aircraft, and defence planners also felt that the problem of protecting Canada's northland demanded a mobile missile carrier, while others claimed that such a weapon was obsolete in the missile era. Not only Avro Aircraft but also many subcontractors in the aircraft industry welcome the decision, which will mean continued employment for some 15,000 workers.

● **Budget control power for McElroy ?** United States business interests have indicated that they may press for legislation to give Secretary of Defense Neil McElroy not only the authority to control the big defence budget, but power to allocate all spending.

● **The United States Defense Secretary McElroy** has stated in Washington that the Defense Department will ask Congress for an additional $1,000,000,000 for missiles and other projects. A supplementary appropriation for this amount will increase the Defense Budget for the fiscal year ending June 1958 to approximately $39,500,000,000.

Workshop Briefs

• *An improved version of the Saro SR.53* began flight testing at Boscombe Down on December 18th. The new version, like its predecessor, is fitted with an Armstrong-Siddeley *Viper* jet engine and a de Havilland *Spectre* rocket engine, but the tanks for the rocket propellants have been considerably enlarged, giving the *Spectre* a longer endurance.

• In addition to their standard armament of four 20-mm cannon, the Swedish Air Force's *Saab-29F (J29F)* jet fighters are in future to carry air-to-air rockets to increase their fire power. The rockets will be carried externally in six multiple launchers, each taking four rockets. An F29F will therefore have a total of 24 rockets.

• *An automatic landing system* has been developed and successfully tested by the *Autonetics Division* of *North American Aviation, Inc.*

• *Grand Central Rocket Company,* Redlands, California, has gone over to remote control automation in its mixing and curing operations for solid propellants. The first installation was a remote temperature control system for a long line of underground "curing" ovens. By mid-January 1958 the company will have in operation the largest solid propellant mixer in the United States. Built at a cost in excess of $100,000, the mixer has a capacity of 2,500 lb. of solid propellant per hour and will raise the company's current production to 1,500,000 lb. of solid propellant per month.

• Older marks of the *English Electric Canberra* may be converted into target drones for use at the Woomera rocket range in Australia.

• The *Lockheed JetStar* all-purpose jet has been tested throughout its speed range during recent weeks, operating from a number of conventional airfields. It reached maximum speeds of more than 600 m.p.h. and rates of climb of around 6,000 ft/min.

• The *Macchi MB.326* jet trainer recently took off on its first flight from Venegono Airport.

• A *special version of the Atar* for flight at very low altitudes has been tested by SNECMA under the N.A.T.O. strike fighter programme. The engine concerned is reported to be an *Atar E4* with a special fuel metering device and known as the *Atar E4A.* Specific fuel consumption of this model in cruise at low altitudes is said to be 8 percent lower than that of the standard E4 version.

• The *first production Boeing 707* made its maiden flight at Renton, Washington, on December 20th, 1957, taking off in a little more than half the 5,400-ft runway.

• Working under contract to the U.S. Army Signal Corps, *Republic Aviation's Guided Missiles Division* has developed a remote-controlled drone for target reconnaissance and surveillance of enemy movements from the air. The machine, known as a surveillance drone, bears the designation SD-3 and is equipped with what are described as "advanced surveillance sensory devices". It can be operated in all weathers and has three interchangeable nose units containing different equipment, enabling it to be used for varying missions, such as photography, radar surveillance or infra-red reconnaissance. The SD-3 is launched by means of boosters from a zero length launcher and is recovered by parachute.

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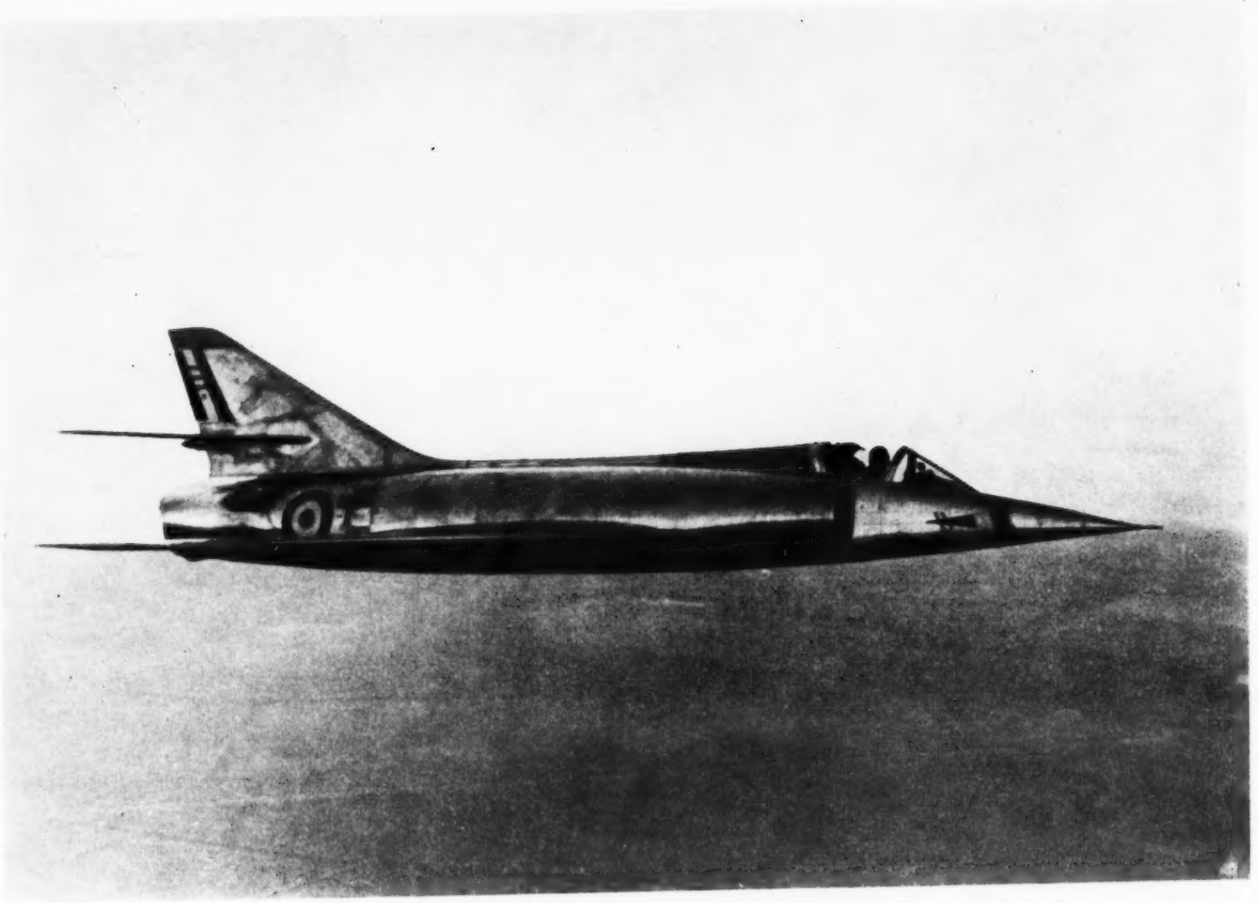

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is the versatile aircraft

of Czechoslovak manufacture,

the L 60 BRIGADYR

with a 220 b.h.p. Praga-Doris engine

It can be used for :

agriculture
ambulance duties
liaison service
glider towing or aerial advertising
passenger and freight transports
aerial mapping
patrol and reconnaissance duties,
etc.

Its universal use is enabled by the following flying characteristics :

short take-off run,
short landing distance,
low stalling speed and
high maximum speed.

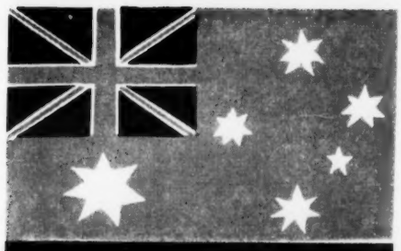
Ask for a special offer with further particulars of the advantageous features of the L 60 BRIGADYR.

Omnipol Ltd.

Praha 3, Washingtonova 11, Czechoslovakia

REPRESENTATIVES:

ARGENTINE: Dr. M. Insua, Arenales 1161, Buenos Aires
AUSTRIA: Ing. A. Rutte, Berggasse 16, Wien IX
BELGIUM: R. Heuvelmans, 36 Avenue Albert Jonnart, Bruxelles
DENMARK: Hamers-Luftfahrt, Vesterbrogade 54, København V
FINLAND: Mateko O. Y., Mariaukatu 15, Helsinki
FRANCE: E. A. M., 8, place d'Iéna, Paris XVI^e^
GERMAN FEDERAL REPUBLIC: Autohage m.b.H., Schmittstr. 47, Frankfurt a.M.
HOLLAND: R. Uges, Handelsmaatschappij « Het Oosten », Thierenskade, Rijswijk ZH
SWITZERLAND: Aero-Craft, Bahnhofstrasse 77, Zurich



AUSTRALIA

FIRST IN THE COMMONWEALTH WITH

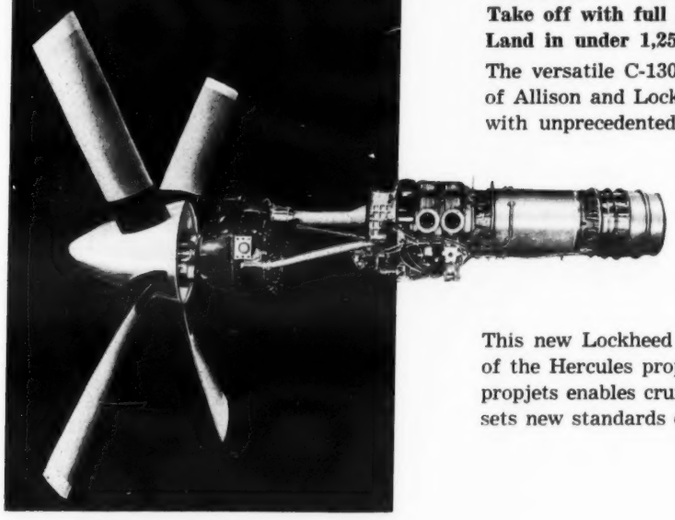
C-130 HERCULES

With the purchase of 12 Allison-powered Lockheed C-130 propjet Hercules, Australia takes her place among the leaders of the Jet Age in logistical transport. This modern Strongman of the Skies flies faster, farther, **and at less cost,** than any other military transport !

Four 3,750 h.p. T-56 Allison propjet engines with matched Aeroproducts propellers give Hercules the power to :

Transport 92 fully-equipped combat troops or 64 paratroopers at speeds up to 350 miles per hour.
Accomodate 74 stretcher patients.
Take off with full payload in as little as 2,000 feet.
Land in under 1,250 feet.

The versatile C-130 Hercules—product of the teamed engineering skills of Allison and Lockheed engineers—will provide the RAAF with unprecedented mobility and operational freedom.



Hercules power for new propjet Electra

This new Lockheed airliner—the Electra—is powered by a commercial version of the Hercules propjet engine. The 15,000 h.p. of its four Allison propjets enables cruising speeds of over 400 miles per hour . . . sets new standards of economy for the operator, comfort for the passenger.

ALLISON PROP-JET POWER

. . . backed by the worldwide resources of

GM
GENERAL MOTORS

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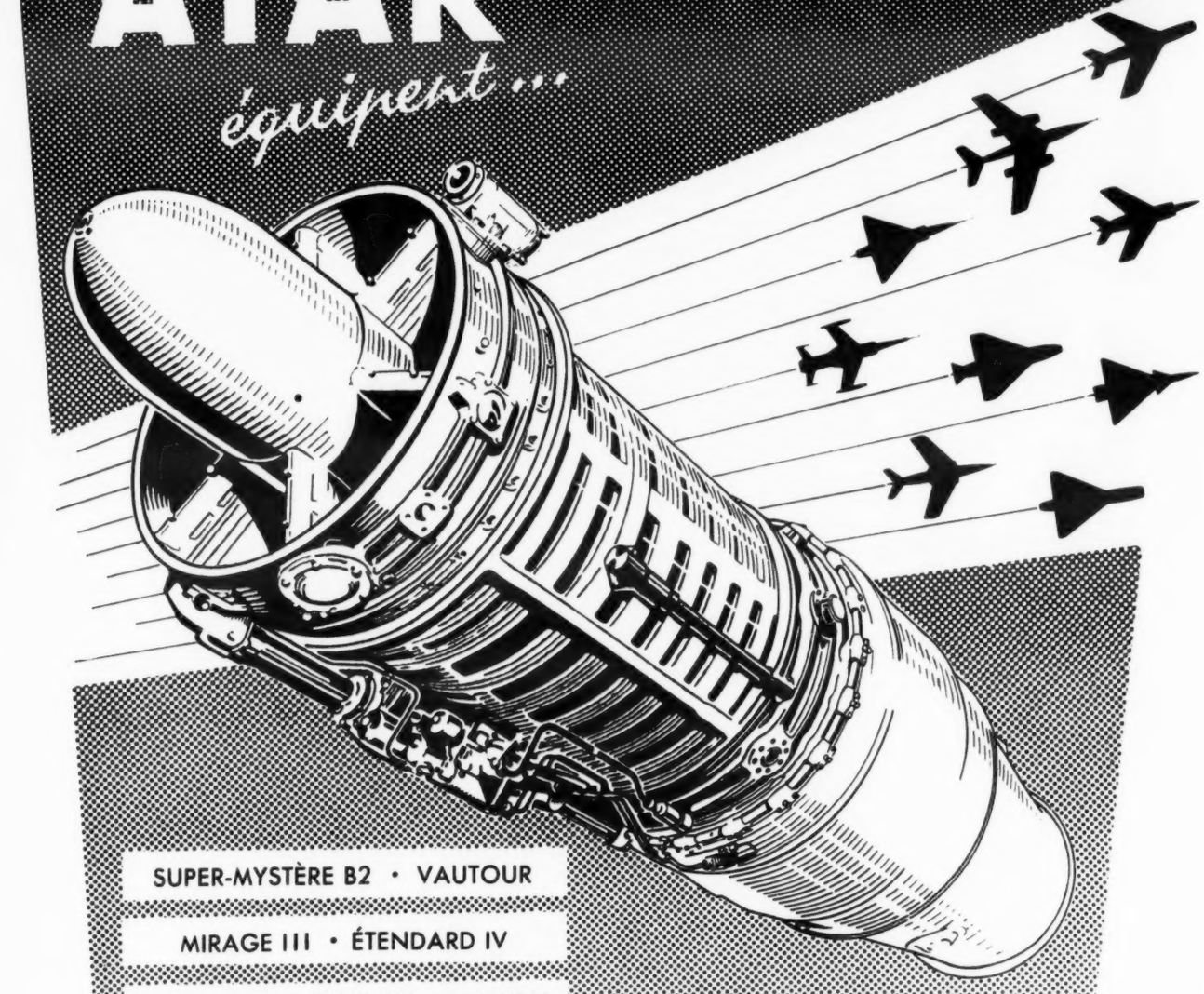
équipent...



SUPER-MYSTÈRE B2 • VAUTOUR

MIRAGE III • ÉTENDARD IV

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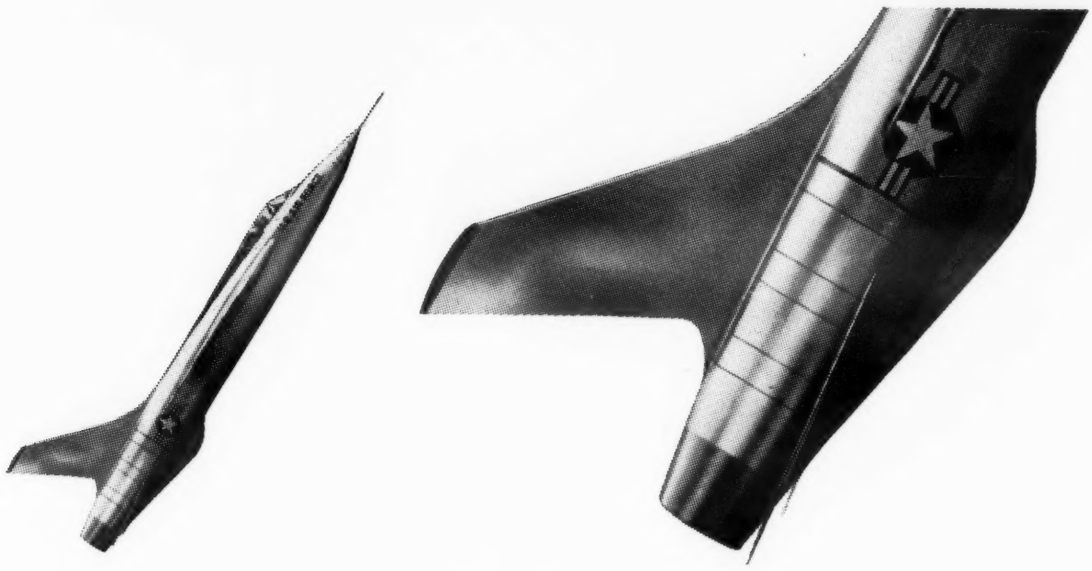
BAROUDEUR • DURANDAL

SOCIÉTÉ NATIONALE

D'ÉTUDE ET DE CONSTRUCTION DE MOTEURS D'AVIATION

150, BOULEVARD HAUSSMANN PARIS-VIII[e]



NOW YOU SEE IT · · NOW YOU DON'T

THE F-105

Furious speed . . . smashing primal power . . . overwhelming persuader for peace, this new Thundercraft, more than any other . . . is designed to deliver Tactical Air Command's composite air strikeforce knockout punch at any target, any time!*

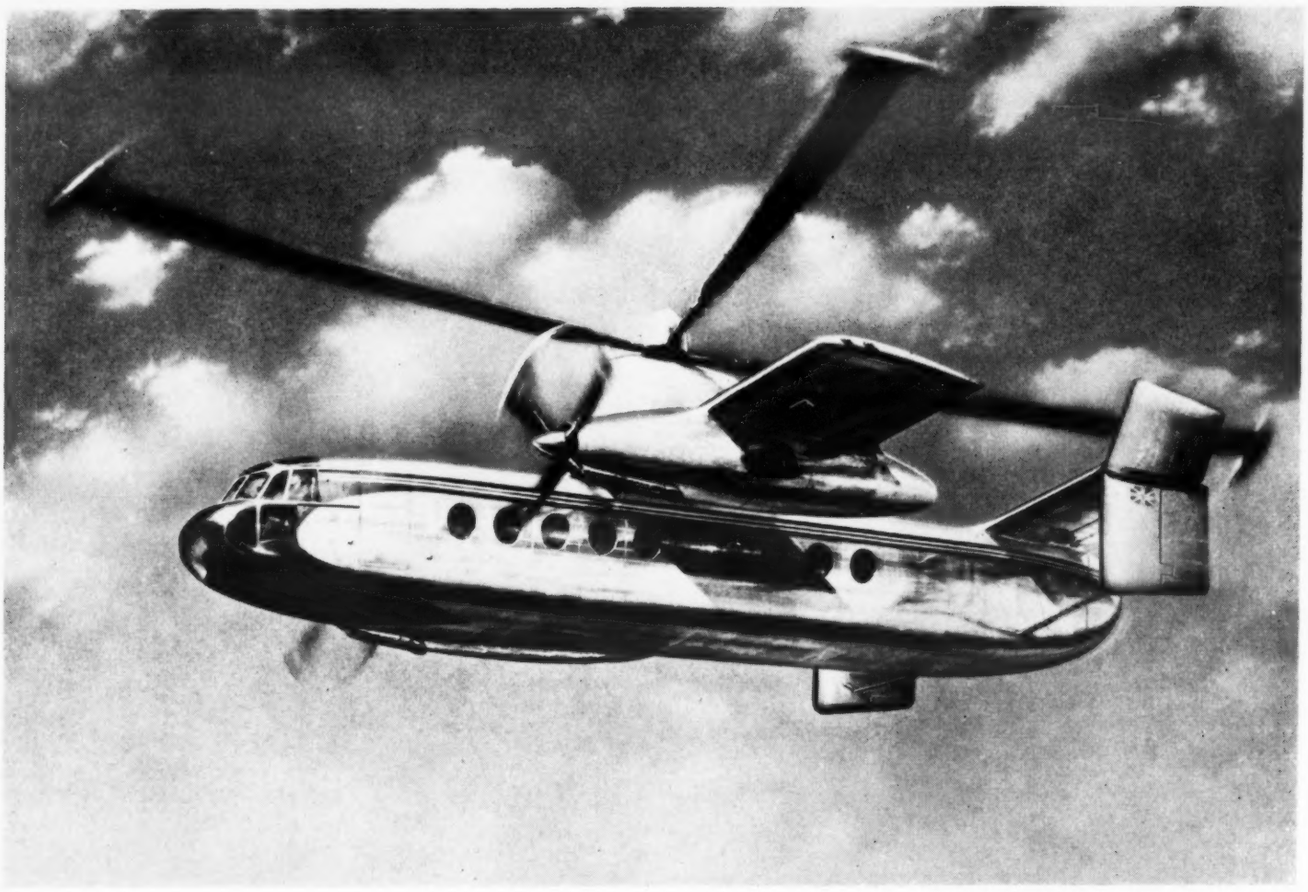
**Latest in the line . . . The THUNDERCHIEF*

REPUBLIC AVIATION

FARMINGDALE, LONG ISLAND, N. Y.

Designers and Builders of the Incomparable **THUNDER-CRAFT**

1956 – Fairey flew fastest



1957 – Fairey flies the first Vertical Take-off Airliner

ADDING achievement to achievement, Fairey Aviation, holders for almost two years of the World Absolute Speed Record, have now built—and flown—potentially the most important transport aeroplane in the world, the Fairey Rotodyne.

Carrying 48 passengers or 4½ tons of freight it takes off vertically as a helicopter and having gained height flies forward as a normal twin-engine airliner.

It is the most adaptable rotary-wing aircraft in the world and the first to offer operating economy directly comparable to that of fixed-wing aircraft over ranges of up to 400 miles.

The arrangement within the Rotodyne's capacious fuselage can readily be adapted to suit civil or military applications. Powered by two Napier Eland propeller-turbines with Fairey Pressure-Jets at the rotor-tips for take-off and landing.

FAIREY

The Rotodyne

48 passengers - 185 m.p.h. cruising speed - 400 miles maximum range

THE FAIREY AVIATION COMPANY LIMITED · HAYES · MIDDLESEX · ENGLAND — AUSTRALIA — CANADA

U.S. Air Transportation and Aircraft Industry at the Year's End

BY SCOTT HERSHEY, NEW YORK

Market analysts, like a good many other people these days, are gazing into their somewhat clouded crystal balls trying to see what the New Year holds in a world in which space vehicles, rockets and missiles are dominant topics. The market analysts, at this point, are trying to figure our annual earnings and seeking a guide as to whether optimism or pessimism will be rampant as the Stock Market moves into 1958.

There is little doubt that outer space has set the stage for some changes in the securities markets of the free world. Wall Street's interpretation of new developments in this field was that there will have to be a change in the value of securities. The Stock Market recently has been largely a matter of who had what in rockets, high energy fuels and various types of Sputniks.

A handful of stocks that have interests in the so-called exotic fuels have caught the fancy of many, and aircraft and missile stocks have been popular. So far as aviation securities generally are concerned, there is lots of talk around Wall Street of lush new defense orders, and it has had its effect on most aircraft stocks and those of related industries. There is still a note of caution, however, as those who buy and sell shares of stock in Wall Street want to know for sure what company has the best of this or that.

The market has been subject to a series of emotional gyrations and gone through some of the sharpest slumps and rallies in recent years. The result so far as aviation securities is concerned, however, has not been decisive. Most aircraft stocks, with some exceptions, are somewhat above their 1957 lows, but at figures which have not yet caused shareholders to throw their hats in the air. The airlines continue to hover around or very slightly above their lows of the year.

The Martin Company seems to pace the missile-plane group whenever the market shows any strength, and there has been support for such companies as Sperry, North American, Boeing and General Dynamics. Some others have moved nervously, but show no gains, or losses either for that matter, which are very significant.

With the nation's missile program—or lack of it, depending on the viewpoint—the subject of so many contrary and controversial statements, it has been difficult for analysts to come up with very positive reactions for the long haul. That something is being done and will be done, nobody denies. But the question remains—just what—and where will the funds from the increased defense budget finally go.

★

An important group of Wall Streeters, the members of the Aviation Securities Committee of the Investment Bankers Association, recently declared that " under the violent fluctuations of Defense Department procurement policy, the aircraft manufacturers may find it increasingly difficult to obtain the capital funds and long-term credits necessary to finance America's air defense."

This Committee, of which Donald M. McDonnell, of Blyth and Company, is Chairman, proposed at the recent convention of the Investment Bankers Association a three-point program designed to put the nation's air transport industry on a sound financial footing and to strengthen the manufacturing industry. The report recommended :

1. A change in C.A.B. regulatory philosophy from the " narrow " concept of rate of return on depreciated assets to a " broad " philosophy of adequate investment return, including a conservative operating ratio, both of which will certainly require a general airline passenger fare increase.

2. Appointment by President Eisenhower of a " highly qualified " person to make a complete review of the Civil Aeronautics Act and C.A.B. procedure and present to the President and to Congress a concrete program for constructive action.

3. A meeting by Secretary of Defense McElroy with a permanent industry committee to negotiate workable solutions to industry problems such as delayed renegotiations, procurement fluctuations, subcontracts and non-reimbursed design changes.

The bankers' committee emphasized what a lot of air transport people have been contending for some time when it stated that " under the restrictions of Civil Aeronautics Board regulation, the airlines lack the earning power and financial strength to serve the public adequately and to finance new jet equipment that will require more capital than at any time in airline history."

The airlines, the report said, not only must be allowed an adequate rate of return on total investment, but sufficiently low operating ratio to provide earnings, stability and growth, and added a rather grim warning : " The alternative is to admit that America, with the world's richest economy, can afford but a second-rate air transport system."

The report appeared just about the same time that figures became available on the airlines' nine-months operations, which told a now familiar story—an increase in total operating revenues and a decline in net operating income.

Total operating revenue of the 12 leading domestic airlines increased by $137 million to a total of $1,190,967,000 for the nine months period. On the other hand, there was an increase of $173 million or 18 1/2 per cent in operating expenses to $1,121,141,999.

Net operating income for the 12 lines amounted to $69,836,000 for the period, a crop of $35 million or 33.4 per cent from the $104,858,000 cleared on operations by these carriers in the like 1956 period.

Only one airline, Northeast, actually showed a deficit for the period, with operating revenues of $11,010,000 as against $7,827,000 for the same period last year, but net operating income showed a deficit of $2,634,000 as compared with a deficit of $30,000 for last year's period.

Pan American's figures showed operating revenues of $239,484,000 as against $216,588,000 the year before, but net operating income was $16,152,000 as compared with $21,371,000 in the 1956 period.

For all the 12 domestic lines, revenue passenger miles were up to 20,250,434 as against 17,469,000, but load factor for the group declined slightly from 65.4 to 63.1.

With more and more people concerned, including the important Investment Bankers Association, perhaps the New Year will bring smoother financial flying weather.

INTERNATIONAL MEETINGS AND CONFERENCES

Jan. 13th-17th : Society of Automotive Engineers Annual Meeting and Engineering Display. Detroit.

Jan. 14th : RAS - "Medical Aspects of Modern Aviation" by W/Cdr. Lewis. Cambridge, England.

Jan. 14th-15th : Instrument Society of America Fair and Symposium. Boston.

Jan. 15th : RAS - "Nuclear Propulsion of Aircraft" by R. E. Wigg. Chester, England.

Jan. 15th : Institute of Production Engineers Southern Region Meeting ; "International Geophysical Year". In conjunction with RAS. Southampton, England.

Jan. 20th-Feb. 7th : Aviation Institute for Commercial Carriers and Business Pilots. University of Southern California. Los Angeles.

Jan. 21st : IATA - Handling and Accountancy Working Group. Rome.

Jan. 21st-25th : ICAO - RAC Committee of 4th European-Mediterranean Regional Air Navigation meeting. Geneva.

Jan. 21st-Feb. 14th : WMO - 2nd Session of the Synoptic Meteorology Commission. New Delhi.

Jan. 22nd-26th : International Air Show and Exposition, Miami, Florida.

Jan. 27th-31st : IAS 26th Annual Meeting, New York.

Jan. 28th : IATA - Traffic Conference I, Agency Committee, New York.

Jan. 28th-Feb. 24th : ICAO - 4th European-Mediterranean Regional Air Navigation meeting. Geneva.

Jan. 29th-31st : American Physical Society Annual Meeting. New York.

Jan. 29th-31st : American Astronautical Society 4th Annual Meeting. New York.

Jan. 30th-31st : American Society for Engineering Education, 1958 College-Industry Conference. Ann Arbor, Michigan.

Jan. 30th-31st : Southern California Meter Association 7th Annual Instrument short course. Wilmington, Calif.

Feb. 3rd-4th : ARDC and Cook Research Laboratories ; Flight Control Panel Integration. Dayton, Ohio.

Feb. 4th-6th : 13th Conference of the Reinforced Plastics Division, Society of the Plastics Industry. Chicago.

Feb. 6th : IPE - The 1957 Viscount Nuffield Paper. "Technical Education for Production Engineers", Lord Hives. Bristol.

Feb. 22nd-Mar. 10th : International Fair, Nice.

Feb. 24th-Mar. 11th : ICAO-WMO Telecommunications meeting. Geneva.

Feb. 26th-Feb. 27th : Air Force Association 3rd Annual Jet Age Conference. Washington.

Feb. 27th-Mar. 22nd : Australian Industrial Fair. Melbourne.

Mar. 2nd-11th : Leipzig Spring Fair.

Mar. 9th-16th : Vienna Spring Fair.

Mar. 14th-23rd : Helsinki Industrial Fair.

The Mind of Mr. Reader

East German Lufthansa replies...

Sir,

... We regret that we have today noted an error in *Interavia* No. 9, 1957, on p. 856, in the brief article entitled "Deutsche Lufthansa Forges Ahead". This article contains the following passage on the Deutsche Lufthansa of the East German Democratic Republic : "First it corrects the airline's timetable (as also sent to *Interavia*) : there are not 20 services a week to Moscow, but only ten, not 10 weekly services to Warsaw, but only two, and so on."

As the Editors themselves write, they have seen our timetable. As *Interavia's* Editors are doubtless experts on air transport, they should be able to read our timetable without difficulty, and not take over so-called "corrections" from the "Bulletin of the Federal Government" without checking.

Nowhere in our timetables is it stated that the Deutsche Lufthansa alone flies twenty times a week to Moscow or the like... In our international timetable all the air services from Berlin-Schönefeld are accurately listed. The West German Lufthansa, in its "aggressive statement"—as *Interavia* calls it—based its remarks on our domestic summer timetable. This correctly includes the following note : "Please note also the favourable international air services from our central airport, Berlin-Schönefeld. The following direct services are operated weekly : 20 flights to Moscow, 6 flights to Bucharest... etc." ... As you will certainly know, we are agents for 10 foreign airlines. We therefore regard it as our duty to draw the attention of air travellers, to whom our timetables are after all addressed, to *all* the air services operated from our central airport of Berlin-Schönefeld...

Berlin W8,
Französische Strasse 53-56

DEUTSCHE LUFTHANSA
Press Office
(Queck)

***Interavia* willingly notes that the statement in the timetable refers to the services of all the airlines operating to Berlin-Schönefeld. — The Editors, however, do not quite agree with the interpretation of the word "aggressive" as used in the article in No. 9, 1957. The term "aggressive" was employed not in reference to the "timetable corrections", but in connection with the statement by Lufthansa A. G., Cologne, that it will take action against any third party using the firm's name.**

The launching weight of missiles

Sir,

... as regards the characteristics of guided missiles which you published in your No. 8 issue of *Interavia* (August 1957, p. 798) ... If I take as example the characteristics which you give for the American *Atlas* intercontinental ballistic missile (5,000 miles range), the calculations which I have made lead me to think that the figure of approximately 100,000 lb. you give for the launching weight is very inaccurate. In my view, this would be the weight without the first launching stage and its two solid-propellant rockets of 100,000 lb. thrust each. This weight might be possible, at an optimistic estimate, to complete the trajectory of 5,000 miles with a warhead of about 1 ton—but for the total launching weight at least another 150,000 lb. must be added to allow for the first stage, which would give a total weight of around 250,000 lb. for the complete *Atlas*.

A less detailed examination of the other weights in your table suggests to me that they may be no more reliable.

Paris.

J. JARRY,
Président, Association française des ingénieurs et techniciens de l'aéronautique.

As regards the *Atlas* launching weight, information which has become available since publication of the table reveals clearly that the figure must be more than 100,000 lb.—more likely double this figure. On the other hand, the *Atlas* is not a multi-stage rocket in the true sense of the word. Though it is launched with two liquid-propellant rocket motors (not, as M. Jarry states, with solid-propellant rockets) and continues its flight on a third liquid-propellant rocket motor, all three motors are mounted close together, and it has not yet been ascertained whether the launching motors are jettisoned after burnout or not. It is obviously almost impossible to avoid all errors in describing weapons still in the development stage, but *Interavia* feels that the final sentence of the above letter is not justified.

Russian antenna or British searchlight ?

Sir,

At the bottom left-hand corner of page 1235 of this month's *Interavia* (No. 12, 1957), under the heading "Russia's Contribution to the Geophysical Year", you publish a picture purporting to represent a "mobile antenna array for radio wave measurement".

It may interest you to hear that this is actually a picture of a standard, radar guided, 150 cm mobile searchlight as used by British Anti-Aircraft batteries during the War.

The two square-shaped boxes on the left and right are the radar screens. On the extreme right, mainly out of the picture, is the searchlight operator's seat (it was the privilege of yours faithfully to occupy this position).

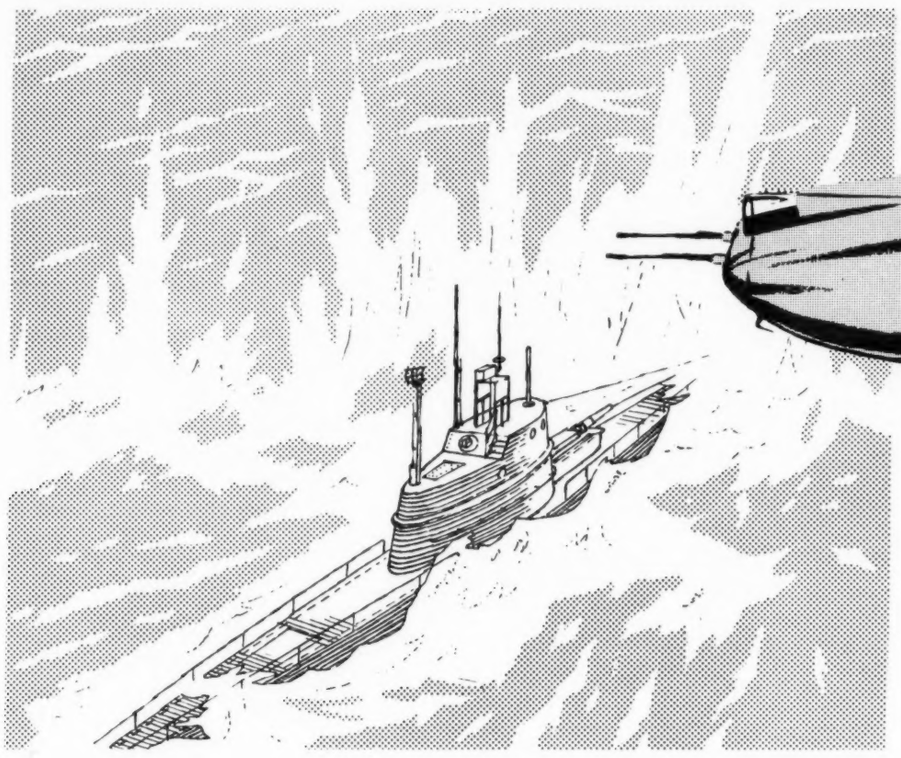
Nothing appears to have been added. One or two things are missing, such as the radar aerials, mounted on top of the barrel, and the fourth seat, with the search radar screen, normally situated behind the barrel.

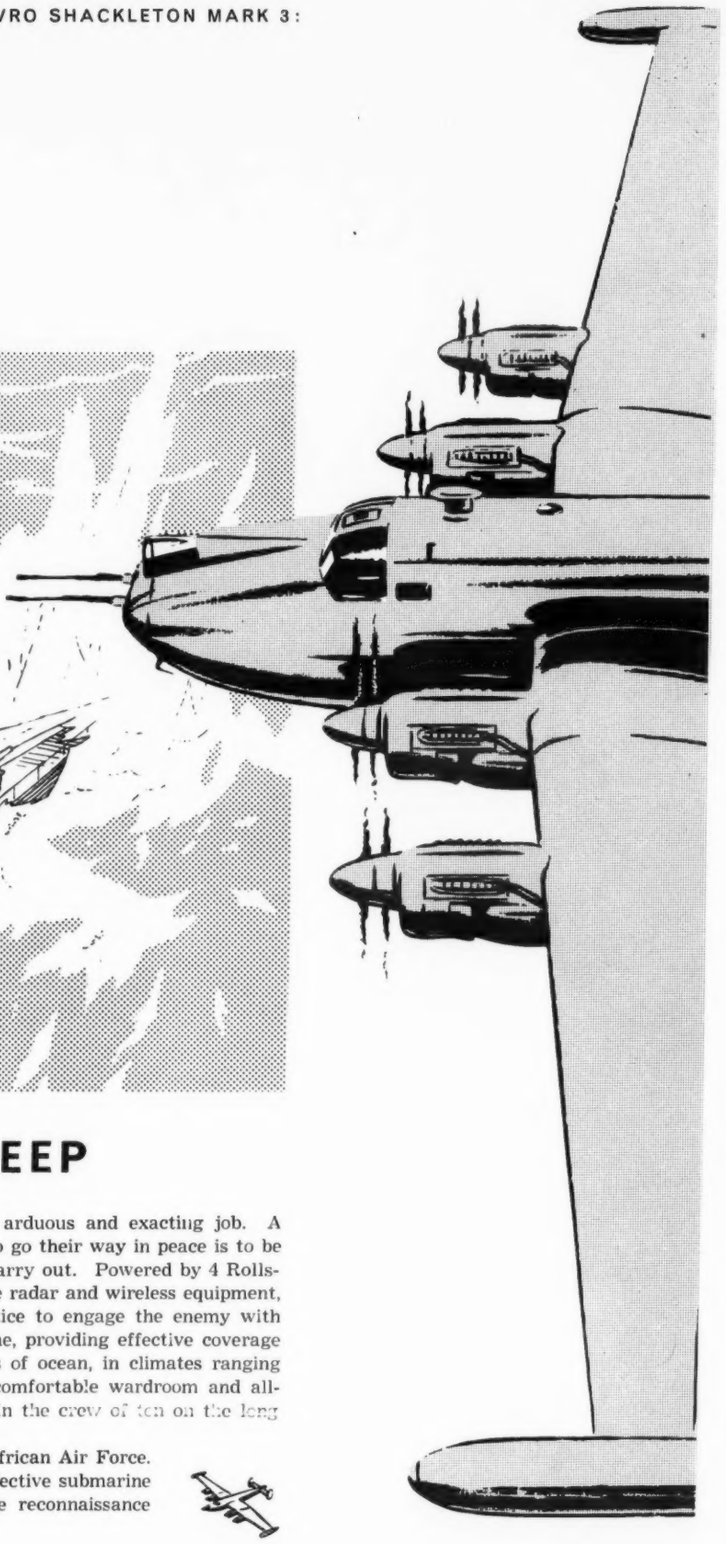
Bilston, Staffs. *G. ODGERS.*

Though the sun comes from the East, there is still apparently nothing new under it.

Photo credits : Front cover : Interavia ; pp. 31-34 : manufacturers (1), Interavia map (1), Interavia files (2) ; pp. 35-37 : Interavia drawings ; pp. 38-41 : manufacturers ; pp. 42-44 : Interavia files ; pp. 45-46 : Sovfoto (5), ATP (1) ; pp. 51-55 : author ; p. 56 : Interavia files ; pp. 57-59 : manufacturers ; p. 60 : manufacturers ; p. 61 : Fotokhronika Tass ; pp. 62-63 : Alitalia (16), Interavia files (3) ; p. 64 : Port of New York Authority (2), Air France (2), K.L.M. (1) ; pp. 65-66 : U.S.A.F. (1), manufacturers (8), Interavia files (1) ; pp. 71-72 : manufacturers ; p. 74 : manufacturers (1), Interavia files (2) ; p. 75 : manufacturers.

THE OPERATIONAL ROLES OF THE AVRO SHACKLETON MARK 3:





WATCH-DOG OF THE DEEP

Guarding the oceans and watching over seaborne traffic is an arduous and exacting job. A job nevertheless, of vital importance if the security of those who go their way in peace is to be maintained. A job the Avro Shackleton is admirably fitted to carry out. Powered by 4 Rolls-Royce Griffon engines and carrying almost 1 ½ tons of sensitive radar and wireless equipment, the Avro Shackleton is ever vigilant — ready at a moment's notice to engage the enemy with deadly effect. This aircraft can operate for great lengths of time, providing effective coverage and defense of countless miles of vital coastline or vast stretches of ocean, in climates ranging from tropical to arctic. The Avro Shackleton even has a large comfortable wardroom and all-electric galley where pre-cooked meals can be prepared to sustain the crew of ten on the long vigil.

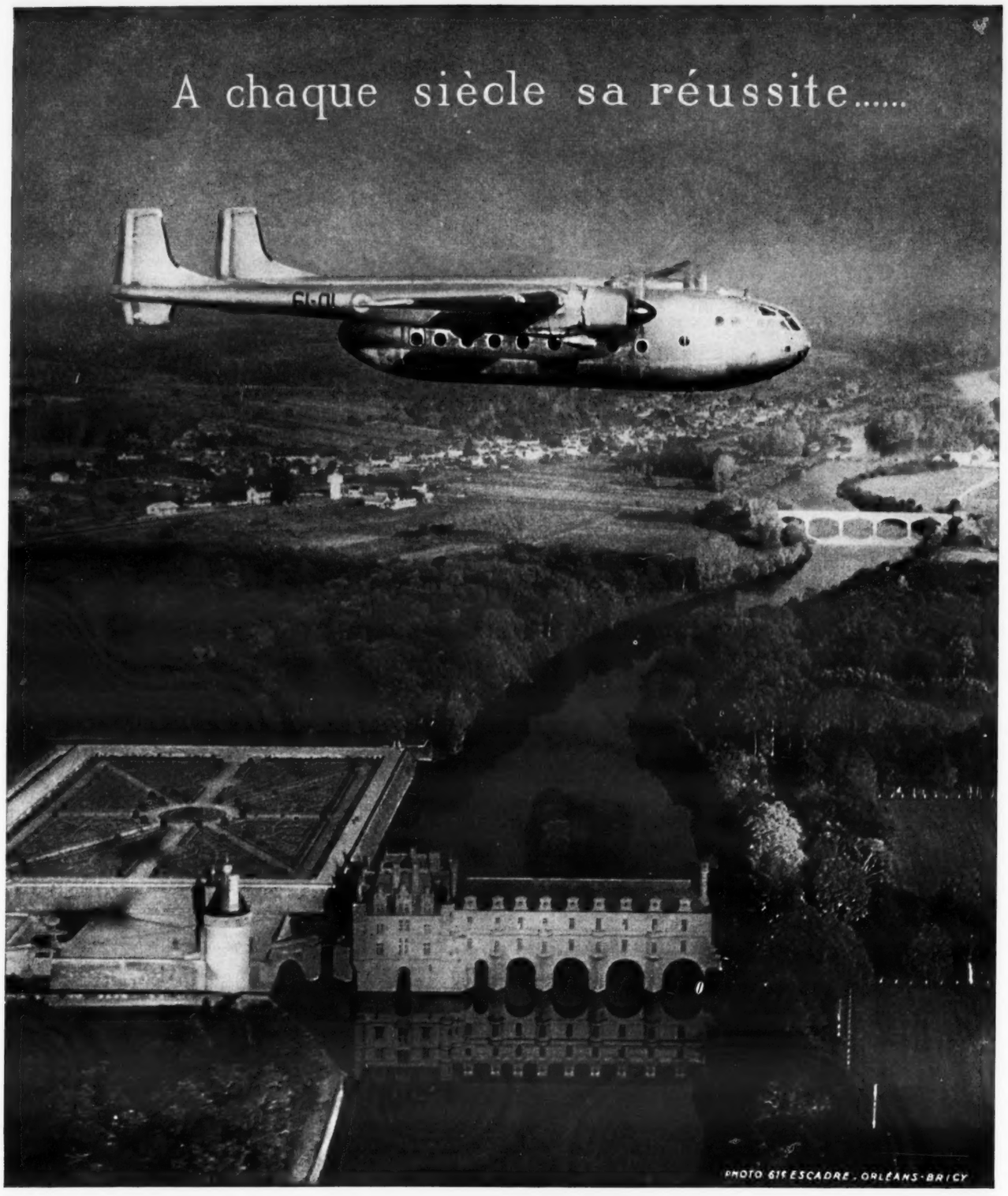
Eight of these great aircraft are now in service with the South African Air Force. They will provide the Coastal Command with the world's most effective submarine killer as well as carrying out vital sea/air rescue and maritime reconnaissance missions.

AVRO **SHACKLETON**

MARK 3

A. V. ROE & CO. LIMITED, MANCHESTER, ENGLAND

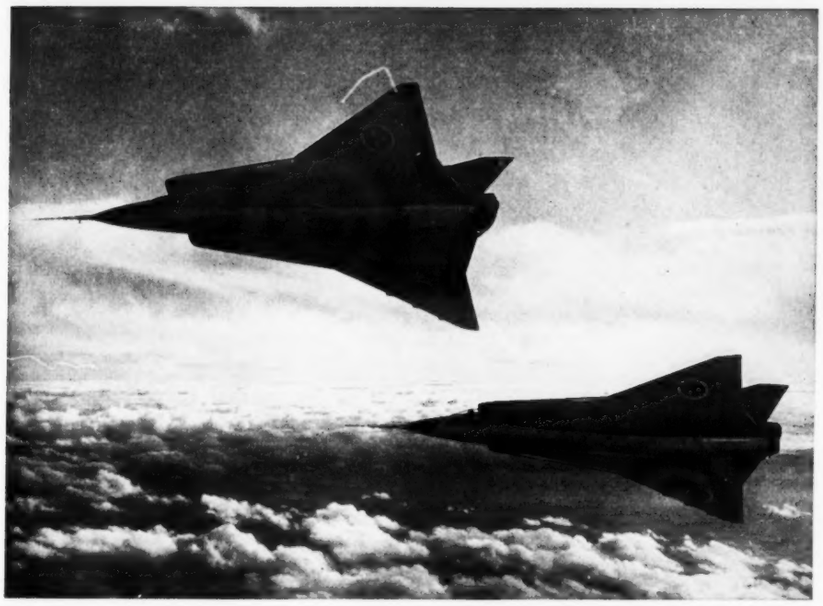
Member of the Hawker Siddeley Group/Pioneer ... and World Leader in Aviation



S.N.C.A.N

Société Nationale de Constructions Aéronautiques du Nord

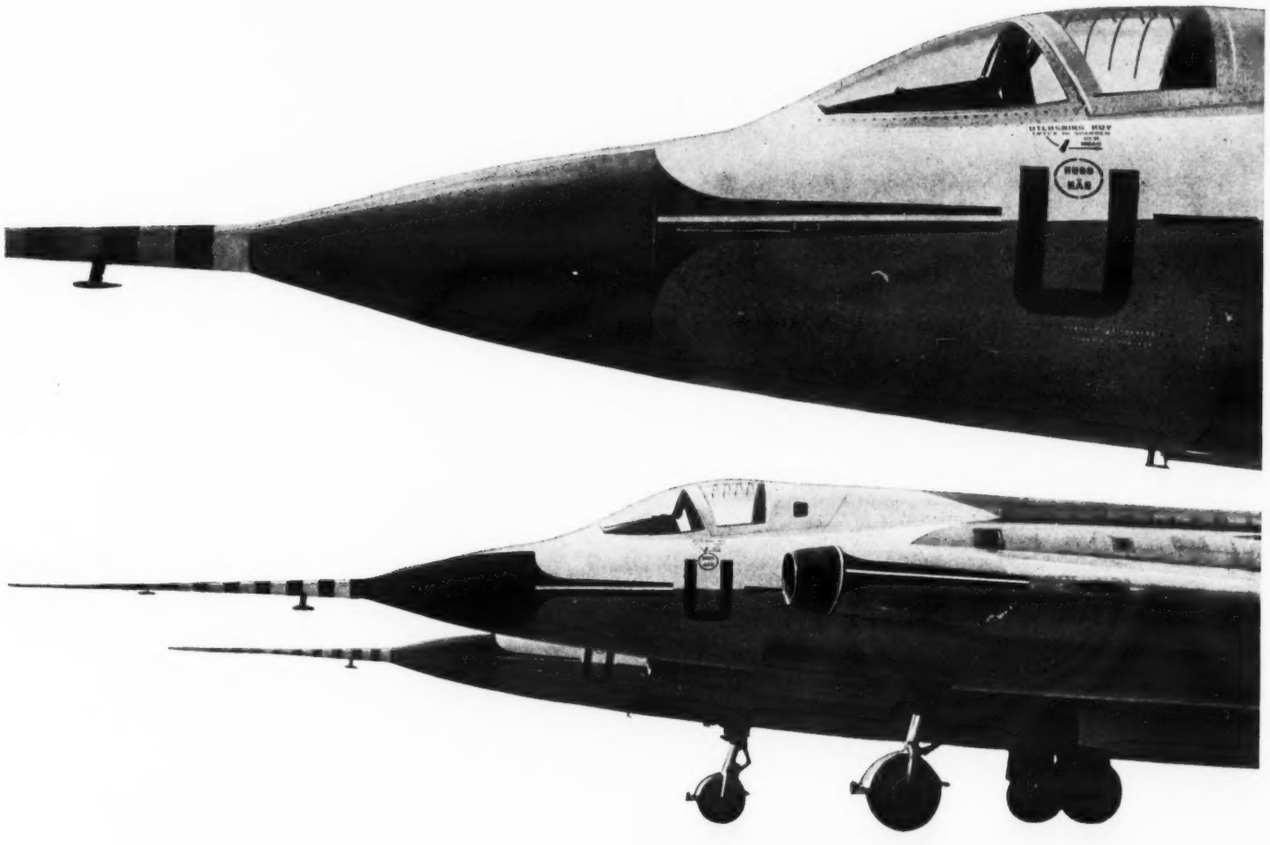
2 à 18, RUE BÉRANGER - CHATILLON-S/S-BAGNEUX
(SEINE) · TÉL. ALÉSIA 57-40



The Saab-35 " Draken " supersonic all-weather jet fighter is one of the most advanced aircraft now in production. The " Draken " combines high supersonic speeds with amazing rate of climb and extremely high operating ceiling. The aircraft has remarkable qualities at both high and low speeds. Its take-off and landing capability enables it to be used from small mountain airfields. The Saab-35 has a Rolls-Royce " Avon " jet engine, with reheat, built in Sweden by Svenska Flygmotor. It can be used equally well as a strike aircraft or a defensive fighter, and its armament consists of canon, rockets and guided missiles.

The Swedish Air Force's first supersonic fighter

SAAB J 35

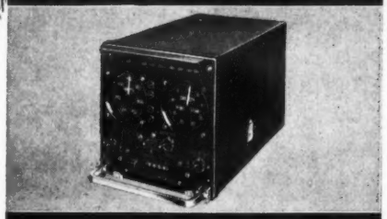


SVENSKA AEROPLAN AKTIEBOLAGET *(SAAB AIRCRAFT COMPANY)* · LINKÖPING · SWEDEN

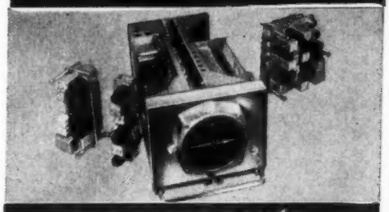
Marconi's hand in radio and radar flying aids

The world of aviation relies upon Marconi's for radio and radar flying aids to match the range and performance of the most modern aircraft and to serve the traffic of the busiest modern airports. But more than that is expected of Marconi's. Working with Governments, Air Forces, Air Lines and Aircraft Constructors, Marconi's are devising electronic equipment which is helping to shape the future of aviation. A great tradition of pioneering and enterprise is being most capably upheld.

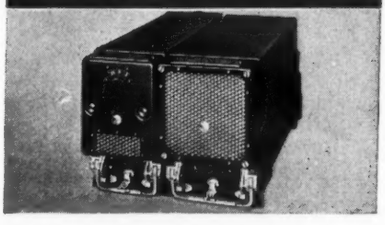
FOR LONG RANGE:
DOPPLER NAVIGATORS



FOR MEDIUM RANGE: A.D.F



FOR SHORT RANGE:
VHF for VOR/ILS Communication



MARCONI

Airport and Aircraft Radio and Radar Systems

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, CHELMSFORD, ENGLAND

No Concrete Airfields Needed

Hidden countryside meadows can become operational bases for squadrons of the new Northrop N-156F supersonic counterair fighters, designed specifically for NATO countries. But this ability to use small unprepared fields or highways is only one attribute of these radically different aircraft.

These small, versatile fighters weigh one-third less than other aircraft of similar ability. As a result combat performance characteristics are outstanding. Wide choices of armament make the supersonic N-156F a deadly weapon against the power of any air aggressor

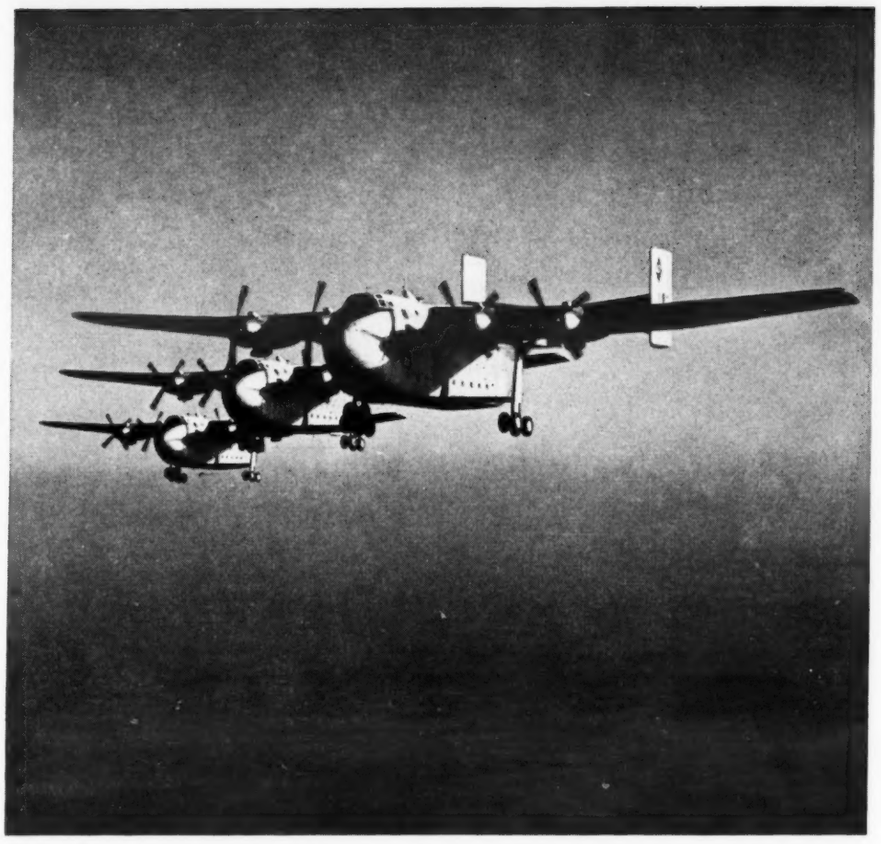
Production cost of the twin-jet Northrop N-156F is as much as 50 per cent lower than conventional heavier aircraft. Fuel consumption is less than half that required by a single larger engine. Maintenance cost is also cut by half due to design and structure simplification, and ground crew man-hours needed can be reduced by as much as two-thirds.

This economical and agile new counterair fighter is another product of the engineering and production team at Northrop Aircraft, Inc., a leader in the development of manned and pilotless aircraft for countries of the free world.

NORTHROP *International*

A DIVISION OF NORTHROP AIRCRAFT, INC. • BEVERLY HILLS, CALIFORNIA, U.S.A.

PRODUCERS OF THE P-61 BLACK WIDOW NIGHT FIGHTERS OF WORLD WAR II, SCORPION F-89 INTERCEPTORS, SNARK SM-62 INTERCONTINENTAL GUIDED MISSILES, T-38 SUPERSONIC ADVANCED TRAINERS, AND RADIOPLANE TARGET AIRCRAFT AND MISSILE SYSTEMS



Blackburn

Designers and manufacturers of aircraft continuously from 1909

Manufacturers of
Transport Aircraft—
High-Speed Naval Aircraft—
Gas Turbines and Equipment
and Piston Engines

BLACKBURN AND GENERAL AIRCRAFT LIMITED · BROUGH · EAST YORKS · ENGLAND

OG99/b

THE TRIDENT II

light interceptor, an experimental batch of which has been ordered, will exceed twice the speed of sound and can use hastily prepared airfields. It is armed with an air-to-air missile carried beneath the fuselage.

THE BAROUDEUR

single-seat tactical support aircraft, powerfully armed and highly manœuvrable, takes off, lands and manœuvres on skids on all terrains.

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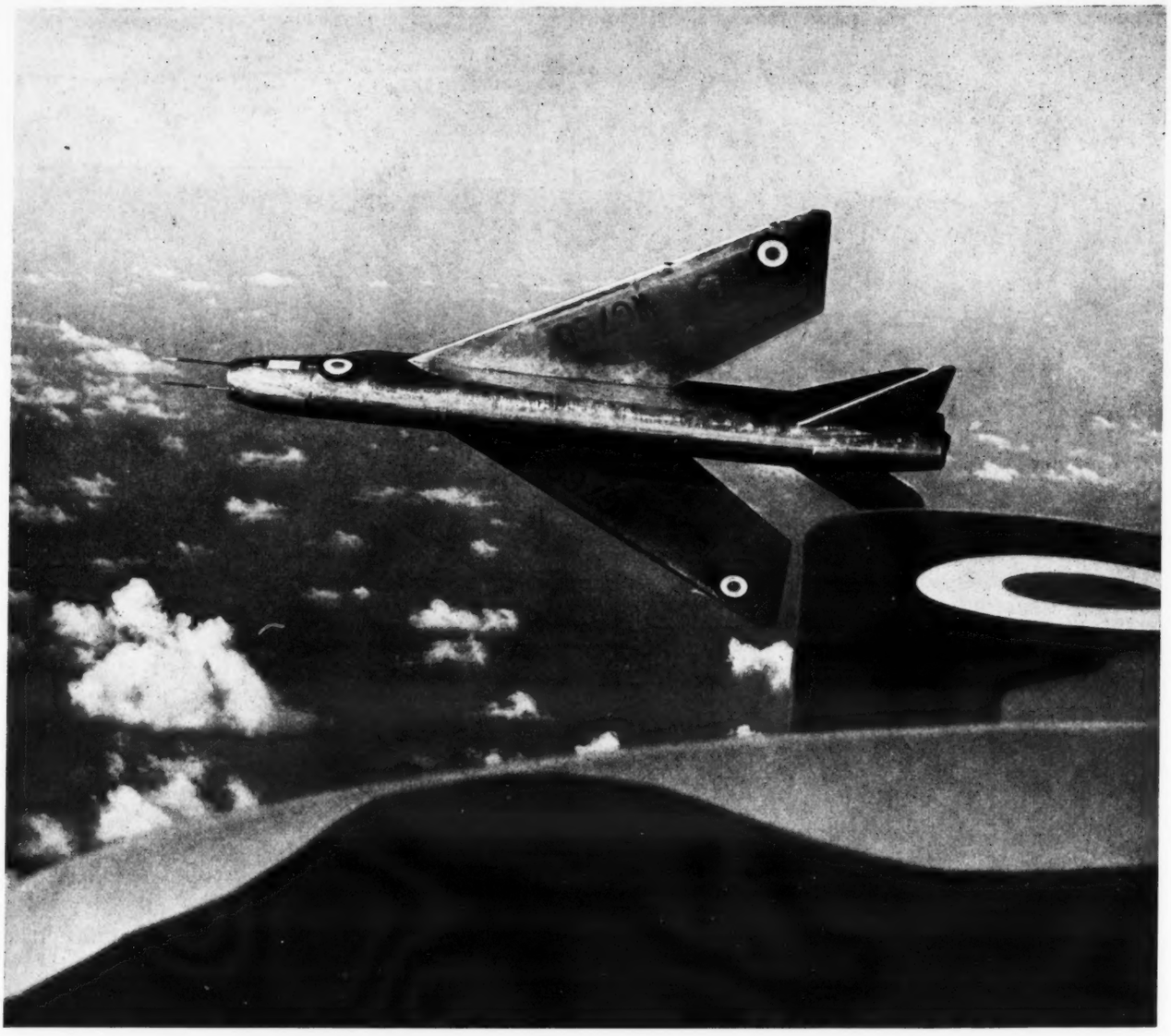

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End or New Beginning for N.A.T.O.?

Prelude to the N.A.T.O. Summit Talks in Paris, December 16th to 18th, 1957

Geneva, December 14th, 1957

At the moment of writing the aircraft bearing the United States President is making its way across the North Atlantic and is due to land in Paris around midday on December 14th. Though he must still take things easily after his recent illness, President Eisenhower is throwing the whole weight of his office and his name into the balance in favour of N.A.T.O., whose first Chief he was. For similar reasons aging German Chancellor Adenauer has cut short his convalescence, and the other thirteen member countries will be represented in full by their heads of government, defence ministers and—last but not least—foreign ministers.

The influx of press representatives has been in proportion to the gathering of Western government leaders: by the evening of December 12th more than 1,800 journalists from all over the world had sought accreditation from the N.A.T.O. press office. On the early afternoon of December 15th they will learn from Paul-Henri Spaak, the new Secretary General, first details of the conference programme.

As N.A.T.O.'s Secretary General or "family doctor", Spaak has mobilized all the leading specialists, to give the ailing organization a "shot in the arm". This time it is a matter of life or death for N.A.T.O. The days when twelve Western nations, led by the United States, banded together to form the North Atlantic Alliance on April 4th, 1949, to construct a dam—military, political and if possible economic—against the pressure from the East, when the very existence of N.A.T.O. was deemed a sufficient deterrent... those days are past. Since then too much has been demanded of the organization, too much has been promised, planned anew and abandoned. Too many changes have been made in the men in the limelight. Only new facts and new, energetic personalities can save N.A.T.O.'s face this time.

The crisis in N.A.T.O., which had been brewing for some time, became apparent when the parliamentary conference met at N.A.T.O. headquarters in the Palais de Chaillot during the second week in November 1957, and outspoken criticism was voiced. The loudest critics at this time were Belgian and Dutch parliamentarians.

Round about the same time Britain's Prime Minister Macmillan journeyed to Washington to infuse new courage into the United States President after the Sputnik blow and to offer British assistance. The intimate talks between the two Anglo-Saxon statesmen, however, were unexpectedly broadened when European Paul-Henri Spaak turned up in Washington like a *deus ex machina* to remind the Anglo-

The Headquarters of the North Atlantic Treaty Organization in the Palais de Chaillot, Paris.

Saxons of the changed situation in Europe: for the first time since the creation of N.A.T.O. the Western Continentals are asking to be partners in such discussions, demanding a full voice and insisting that they are no longer willing to be treated as "sick men" in need of aid.

The real originator of the forthcoming N.A.T.O. conference at the summit is thus Paul-Henri Spaak. Spaak the European, a politician of long experience, whose name is well known in all government circles, seems to have set himself the task of reconciling Anglo-Saxon and Continental European interests.

As though Mr. Dulles could cure the West's Sputnik fever which broke out in November with yesterday's politico-strategic prescriptions alone! As though an offer to supply a few American IRBMs could decisively change the 1958 political picture in Western Europe! As though it would not be just a little too naive to suggest supplying the Europeans with an arsenal of tactical or strategic atom or hydrogen bombs in locked boxes, but keep the keys in Washington! Can it really be assumed that the countries thus favoured will meekly agree to make launching bases available for this equipment? Such at any rate is not the kind of full partnership which the Europeans are envisaging at the moment.

Here it is illuminating to read what Countess Dönhoff, editorialist for the German weekly "Die Zeit", which enjoys wide esteem in Bonn and the Ruhr district, writes on the new situation on November 28th, 1957: "As long as the Russians hold the monopoly of intercontinental rockets, while the Americans have to rely on defence with medium-range rockets, the United States *cannot* do without its Allies in Europe. The days of American isolationism are definitely past. On the other hand, a European isolationism has suddenly become possible, as the idea that a neutral Europe might be able to keep out of a war between the two giants is taking shape..." Though both ideas may at present be wide of the mark, they are no longer pure wishful thinking.

Nevertheless these are the trends which Paul-Henri Spaak must bear in mind, if he has decided to sacrifice his career as a European statesman for that of a big-scale intercontinental politician.

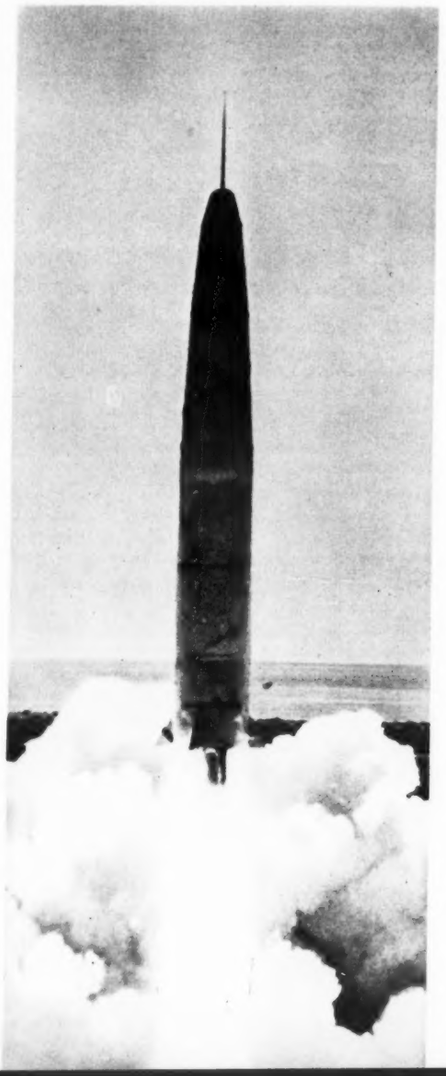
N.A.T.O.'s halo was beginning to pale when Dwight D. Eisenhower, the successful World War II general and first N.A.T.O. Chief, packed his bags in Paris to take over the office of President of the United States. His successors, General Ridgway and later General Gruenther, no longer had a very easy task. And the present N.A.T.O. boss, handsome U.S. Air Force General Lauris Norstad, will probably be realizing more clearly from hour to hour that the job he has taken over in Paris is not a military, but primarily a political one, such as would not normally have fallen within his career.

The most fortunate is Lord Ismay, who was able to lay down the increasingly heavy burden of office as N.A.T.O. Secretary General in 1957. This prototype of an English gentleman might well have been non-plussed by the political assault in the Palais de Chaillot, now facing his successor Paul-Henri Spaak.

Under the original concept, N.A.T.O. was to be the West's "sword and shield". What is the real value of this sword and shield today?

The sword, formed originally by the United States' atomic monopoly and supplemented by the "mailed fist" of the U.S. Air Force Strategic Air Command, has found its counterpart in the Russians' nuclear missiles. The shield, the Western divisions stationed in Europe? Compared with those of the Eastern bloc, they are as weak as they were in 1949. French divisions are in North Africa, British divisions are to be withdrawn to the British Isles, the small number of American divisions would be no deterrent to the Russians, and the German divisions are still being built up. True, there are a few Italian, Dutch, Belgian and Scandinavian divisions, but they won't butter any parsnips.

The United States' Douglas *Thor* intermediate range ballistic missile for a range of 1,350 nautical miles during a test launching at Cape Canaveral.



What still remains obscure is the whole object of the N.A.T.O. strategists' "sandbox games". True, there was at one time a N.A.T.O. doctrine, which was set down in hundreds of memoranda. Some idea of this doctrine can be obtained by referring back to the already yellowing pages of *Interavia* for July and August 1954. Today the doctrine has only one weakness: it is outdated. Is this really surprising?

It is now several years since the U.S. Council on Foreign Affairs commissioned 34-year-old Dr. Henry A. Kissinger, a former German who emigrated to the United States in 1938, to write a book on the highly topical subject of nuclear weapons and foreign policy*. The Council's object was to clarify the new defence situation arising from the fact that the American monopoly in nuclear weapons had been broken by Russian rearmament. Kissinger was to examine all the carefully collected material and write a kind of vademecum for the United States, and hence N.A.T.O.'s, new defence and economic policy.

The outcome of these investigations has been set down in a weighty tome of some 450 pages, which has been extravagantly praised in the world's press. What the ordinary reader will make of the book, however, is another matter. The author is not entirely clear in certain passages. His was a thankless task, and he has fulfilled it in such a way that only the intellectual elite with plenty of time will fully grasp the contents. The man in the street is unlikely to be affected by Kissinger's arguments.

In his book, at any rate, Kissinger proves that the U.S. (and hence N.A.T.O.) sword and shield theory is outdated in its traditional form. In Kissinger's view N.A.T.O. is an alliance which is still seeking its ultimate purpose. N.A.T.O. is trying to combine the no longer very convincing strategy of total atomic warfare with efforts to provide a local defence

* "Nuclear Weapons and Foreign Policy", by Henry A. Kissinger; published for the Council on Foreign Relations, by Harper & Brothers, New York, 1957; suppliers for Europe, Oxford University Press, London; price £2.

Paul-Henri Spaak, Secretary General of N.A.T.O.

for Europe, since the threat of American reprisals as the ultimate deterrent has lost some of its attraction. Would not even an American President have to think twice before employing this last deterrent in the protection of Europe, if by so doing he ran the risk that fifty American cities would be destroyed by Russian long-range missiles? Perhaps, says Kissinger, this nuclear stalemate means that atomic war will become impossible. But the stalemate does not mean that every other form of armed conflict is beyond the bounds of possibility. Where such a conflict might begin and where it might end... Kissinger does not say. But he does make the oracular statement that any attempt to evade such serious strategic problems must lead to disaster in wartime or to a "softening of the alliance" in peacetime. This is probably one of the things which will be discussed in Paris.

By and large, Kissinger recommends that the West should not seek to copy Russian dogmas, but to equal Soviet achievements through democratic means. How this is to be done in practice is not disclosed.

Meanwhile Paul-Henri Spaak is acting as mentor, physician and encourager of the timid, proving himself to be the most brilliant and untiring arguer imaginable.

In Paris recently he argued that the question for the West was not "washing machines *or* long-range weapons"; the West had already decided on both. In Amsterdam the convinced European expressed regret over Europe's inferiority complex since 1945, which has led to acceptance of the fact that the first satellites should be launched by the Russians or the Americans, when strictly speaking Europe, with its intellectual, economic and industrial elite, should have made it a point of duty to be first in this field.

And back in Paris after his return from Washington, Spaak admitted that he had asked President Eisenhower why he wished to deprive his European Allies of something which his presumptive enemy already possessed in quantity...

This brings us to the subject on which the political, economic and military talks in Paris will centre.

It is reported that the Americans plan to supply their North Atlantic Allies with medium-range missiles with no strings attached, but to offer nuclear warheads for them only under certain conditions. The British appear to agree in principle to such proposals, as they have their own arsenal of this type of weapon in preparation and will hence soon become equal members in the "atomic club".

It is also reported, with how much truth is not yet clear, that the Continental European countries plan to put forward a common proposal in Paris, which would ensure them equality within the near future, without in any way jeopardizing their loyalty to the alliance. The questions for discussion in Paris are thus less of a military than of a political nature. Basically, it is entirely in the Americans' interest to make Western Europe strong. The stronger Western Europe, the stronger will be N.A.T.O. and the greater the guarantee of peace embodied in the organization. EEH

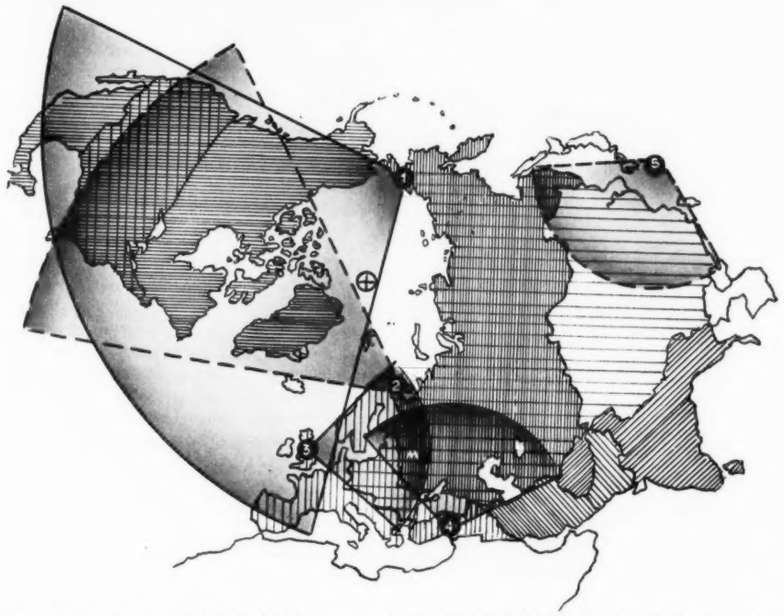
American IRBMs + N.A.T.O. = Soviet ICBMs

The fact that the United States has lagged behind to a certain extent in the development of long-range missiles may be the reason for the renewed interest it is now taking in some regions of the European N.A.T.O. countries.

Today's bomber and tomorrow's long-range missile exhibit certain parallels. The further a bomber is required to fly, the lower its cruising speed; and the further a missile is to be fired, the smaller its accuracy at the target. The intermediate range ballistic missile is thus on an average more destructive, because it is more accurate, than the longer-range intercontinental ballistic missile. The American IRBM is the logical successor to the B-47 and B-58 bombers and, like them, needs bases near enemy territory (close-range strategy).

The very real advantages derived by the North Atlantic Treaty countries from their purely defensive attitude—and a defensive attitude does not in any way imply purely defensive armament—are obvious: the object is not to end a conflict victoriously, but to prevent such a conflict ever breaking out. All member countries are agreed on this principle, but there are still divergencies of opinion on the means to be employed.

Should one of the two "super powers" decide to start a war tomorrow, it would not only have to overcome certain moral scruples, but above all would have to be sure that it could destroy its victim's reprisal forces in their entirety. If the aggressor cannot destroy all the enemy's long-range missiles on the ground, he must be prepared to be exposed to reprisals by all the missiles not destroyed. Thus the aggressor must direct his first blows against well camouflaged point targets, namely the enemy's many rocket-launching bases. Such considerations need not concern the victim of an attack. He should announce publicly that, in view of his basically defensive attitude, he would not hesitate if assaulted to direct the main weight of his reprisal effort against the aggressor's cities.

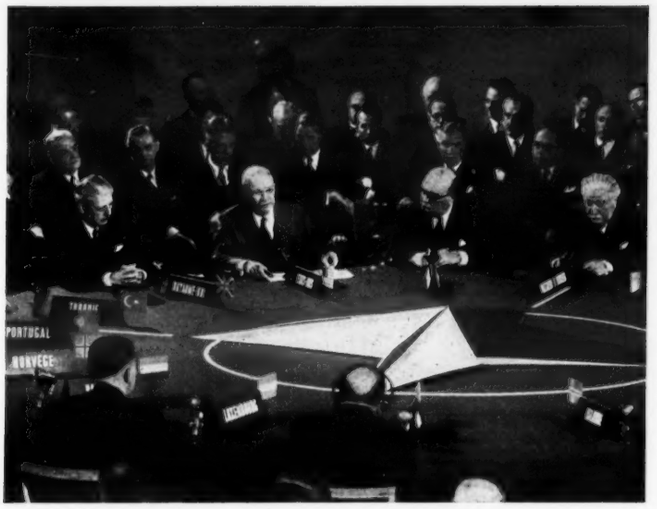


During the next few years the United States can counter the Soviet ICBM threat only with the Strategic Air Command's long-range bombers and a ring of IRBM (*Thor* and *Jupiter*) launching bases. The map shows that the whole of North America lies within the range (4,300 nautical miles) of Soviet ICBM bases in the Chukchis (1) and Kola (2) peninsulas, while American IRBM bases (range 1,350 nautical miles) in Britain (3) and Turkey (4) could cover the whole of European Russia (M = Moscow).

N.A.T.O.

"I Bear War and Peace in my Toga!"

Review of the N.A.T.O. Summit Conference



At the round table in Paris the Anglo-Saxons negotiated . . .

Geneva, December 19th, 1957

The some 30 delegates and 1,800 journalists from fifteen N.A.T.O. countries have departed from the somewhat chilling atmosphere of the Palais de Chaillot. Back home, they are preparing to examine the mountains of paper they have collected... and decorate their Christmas trees.

Nothing of what was written on the morning of December 14th, 1957 as a prelude to the N.A.T.O. Conference need be withdrawn. End or fresh start for N.A.T.O.? There can be no question of an end. On the contrary, a fresh start was tackled, and the coming months will show to what extent N.A.T.O., now raised above the military sphere, can adapt itself politically and economically to the needs of the hour.

The final communiqué recalls the attitude of the envoy of ancient Rome who journeyed to North Africa before the Second Punic War to warn the Carthaginians: The decision is yours; I bear war and peace in my toga!

What will be Moscow's reaction to the Paris manifesto? There were those who maintained during the Conference that the West's fifteen heads of Government were joined at the conference table by a sixteenth, the ghost of Nikita Khrushchev.

*

The four days of discussions between the Government heads, foreign ministers, defence ministers and chiefs of staff revealed the usual ups and downs of all international conferences. The second day was the critical one, when the Europeans voiced their claim to equality as allies, somewhat taking the gilt off John Foster Dulles' gingerbread and ensuring that N.A.T.O. will now pay appropriate attention to political and economic questions.

But already by the end of the second day it was clear that the United States plans to strengthen N.A.T.O. in the 1958/59 fiscal year, by increasing foreign aid funds by some $ 2,000,000,000, of which $ 700,000,000 are to be for pure N.A.T.O. purposes, in particular for the production of non-conventional weapons in Europe. The same day, too, it emerged that the Europeans would not accept the installation of launching ramps unconditionally. Thirdly, agreement was reached in principle on the "brains trust" for the new N.A.T.O., and steps were taken to expand the Standing Group in Washington. Finally, it was agreed that the necessary credits for Europe's well-equipped, but financially weak arms industry should be made available through the Export-Import Bank.

*

Thus when the final communiqué came out around midday on December 19th, 1957, it could hardly contain any surprises. Its nine type-written pages reflected very much what had already trickled through.

The *first part* of the communiqué amounts to a solemn declaration of an extended "Atlantic Charter", a solemn manifesto on war or peace.

The *second part* deals with specific problems which were argued over during the Conference, but on which agreement was finally reached, at any rate outwardly. Cooperation with the S.E.A.T.O. and Baghdad Pacts is provided for, but in obviously flexible terms. Particular emphasis is placed on prior consultation between all member countries, to avoid unilateral decisions or unpleasant surprises. A reorganization and financial expansion of mutual arms aid is guaranteed by the United States from July 1958 onwards, the beginning of the new fiscal year. The United States and Britain will make their experience of guided missiles available to the other member countries. But the establishment of launching bases on the European Continent will be the subject of bilateral agreements between the N.A.T.O. Command and the countries concerned. The United States will make intermediate range ballistic missiles available to those who request them, from the end of 1958. For the time being nuclear warheads will remain in American "safe keeping", as dictated by the McMahon Act. The German-French-Italian pool for the development of "new weapons" was formally agreed to, as an outward symbol of closer Continental European cooperation in military and political matters. The science committee, N.A.T.O.'s "brains trust", is to be placed under a kind of deputy secretary general, and the name of Dr. Theodore von Kármán, present Chairman of the Advisory Group on Aeronautical Research and Development, was mentioned for this post, though the scientist himself was absent in the United States during the Conference.

For the outside observer President Eisenhower, West German Chancellor Adenauer and the young French Premier Gaillard appeared as the key figures. Behind the scenes, the three Continental Defence Ministers Taviani (Italy), Strauss (West Germany) and Chaban-Delmas (France) are said to have done particularly useful work through their political skill and moderation.

*

When, on the second day, the world's most experienced and most highly paid journalists had to kick their heels for hours, waiting for the press conference to begin, a lanky American reporter settled comfortably at one of the tables... and fell asleep. A joking colleague pinned on his breast a card bearing the inscription "I like Nikita"... The coming months will show what the Head of Soviet Russia's Communist Party makes out of N.A.T.O.'s final communiqué. If Nikita Khrushchev has any ear for the pipes of peace contained in the solemn manifesto, the above journalist may well be able to spend his next Christmas with his family. The launching ramps planned today may then possibly remain no more than a project for a long time to come, and "I like Nikita" might become the slogan of the world's press.

The new N.A.T.O. indeed bears war and peace in its toga.

EEH

. . . with the Continental Europeans.

Does N.A.T.O. Need Re-Thinking?

By ***

Conceived in Washington nearly nine years ago, with the signing of the North Atlantic Treaty, N.A.T.O.'s military organization has since undergone numerous modifications, all designed primarily to improve its efficiency.

It would be tedious to list all these modifications. Suffice it to recall, for example, that the second session of the Council, in November 1949, set up a "Military Production and Supply Board". Less than two years later this was replaced by a "Defence Production Board" with wider powers, charged with "expanding and accelerating production and with furthering the mutual use of the industrial capacities of the member nations." A year later, when N.A.T.O. was installed in Paris, this Defence Production Board was in turn replaced by the Defence Production Committee, one of the numerous permanent committees placed at the disposition of the N.A.T.O. Council.

Similar changes have also been made in the Commands. Regional strategic groups have been short-lived. As early as 1950 it was decided that the Allied military forces should be "integrated". As a result General Eisenhower was appointed Supreme Allied Commander, Europe; Supreme Headquarters, Allied Powers, Europe, was set up, and N.A.T.O.'s main subsidiary Commands, Northern Europe, Central Europe and Southern Europe, were created. In 1952 these were joined by the Atlantic Ocean Command, the Mediterranean Command, the Channel Command (including the southern North Sea). N.A.T.O. advanced from the planning to the practical stage.

Soon afterwards, the present organization had come into being, with its supreme authority, the Military Committee; its executive organ, the Standing Group; and its major Commands (Europe, Atlantic, Channel and Canada-United States). In addition to the 13 committees and offices attached directly to the Council, the Standing Group has immediately under its control the Military Agency for Standardization in London, the Advisory Group on Aeronautical Research and Development, the N.A.T.O. Defence College in Paris, the European Military Communications Coordinating Committee, the European Long Lines Agency, the European Radio Frequencies Agency and the European Naval Communications Agency. Numerous inter-Allied staffs, a wealth of communication means, powerful equipment resources—it would seem that everything has been assembled to make N.A.T.O.'s military organization into a highly efficient machine.

Yet, after eight years, pessimistic voices are raised, accusing N.A.T.O. of inefficiency in both the military and the civil fields. Even leading politicians and military men have spoken up, alleging deficiencies and grave failings. The recent progress which the Russians have revealed has been seized upon by many as indicating a need for soul searching, an examination of whether all is for the best in an organization which has cost so much labour, time and money to create.

Once again, it seems that it is not the men who are at fault, but the organizations they have created.

The spirit of the Atlantic Treaty

"The inter-Allied staffs," wrote General Servais,[1] "continue to be the targets of criticism on the part of officers who have become discouraged by too much work which has remained in the mere project stage and by the dearth of concrete progress. The evil is deep-seated. It arises from the very spirit of the Atlantic Treaty, which rejects any suggestion of a supranational authority to replace national sovereignties."

"Decisions are unanimous," writes Lord Ismay,[2] "there is no voting. When governments hold divergent views, negotiation continues until unanimous agreement has been attained. There is no question of, say, ten nations forcing four to do what they do not want to do. The Council are no supranational body; their members are representatives of sovereign states. It is true that unanimity is not always achieved without considerable patience and a good deal of give and take; but it has always been reached in the end." "Considerable patience," adds General Chassin,[1] "means considerable time. And we can well ask whether such an organization is really suited to the dangerously explosive world in which we live."

"When the Council interrupted their session on the 18th September", says Lord Ismay, "all the members were prepared to accept the principle of German participation in the N.A.T.O. forces, with the exception of the French Foreign Minister, M. Robert Schuman... Being thus unable to reach agreement, the Council adjourned in order to allow the Ministers—and particularly those of the three Occupying Powers—to re-examine the matter."

The principle of individual national sovereignty has extremely serious repercussions on the purely military level.

On matters such as the organization of forces, the supply of equipment, methods of training, operational procedures, N.A.T.O. can do no more than make "recommendations" to the various governments, most of the time without practical result.

For example, the various nations have never been able to agree on a common organization system for the ground forces. Each country, arguing from the special missions which would fall to its lot, has planned very different units, which are not interchangeable. These give the overall system a frightening rigidity and make it impossible for the commander to plan his operations with the desired flexibility. American, French, British, Belgian, Canadian divisions all differ in strength, organization, command and, alas, equipment.

Equipment

The Military Agency for Standardization, which has been in existence in London since 1951, has itself come up against the principle of sovereignty and has never succeeded in its task, despite the latter's major importance. A brief glance at the achievements upon which it prides itself is illuminating: adoption of standard characteristics for spark plugs for vehicles, standardization of the dimensions of towing hooks for trailers (!), establishment of preferential lists for tubes and electronic components, preparation of comparative tables of equipment from different countries used in aircraft construction, distribution of production techniques for such items as gun steel and steel plugs and, finally, partial or complete standardization of certain equipment. Leaving aside this last vague statement, which probably does not apply to very much, the balance is seen to be meagre. In fact, it is practically zero. After eight years of discussion, no serious standardization of equipment has been achieved. The adoption of the Belgian rifle was "recommended" by N.A.T.O. to its various member countries. Needless to say, it was not adopted by any of the countries who already produced rifles. Contests such as that for the light strike fighter just concluded at Brétigny, France, cannot lead to anything other than "recommendations". And it is known that some countries are entirely opposed to the very concept of this aircraft category which, however, is officially listed among the types of weapon which the Alliance should possess in order to provide aerial support for any future atomic land war.

The result is that each country arms the forces it assigns to N.A.T.O. with equipment manufactured by its own national industry. Consequently the command has tremendous difficulty in operating this equipment. A British-type ground division stationed in Northern Germany can with difficulty be moved to the southern sector, because of the question of vehicles and repairs, and the converse is equally true of a French or American unit. The Alliance's equipment is a patchwork coat which cannot be repaired in the event of serious rents.

But there are more serious consequences. Often the equipment dictates the tactics adopted and sometimes even the strategy.

[1] "Revue Militaire Générale" No. 2, October 1956.

[2] "N.A.T.O., The First Five Years".

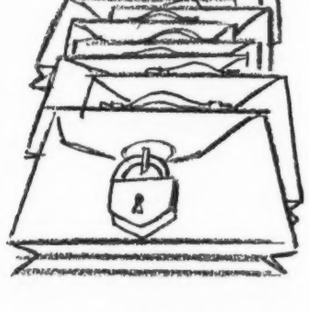
The introduction of new types of radar has led certain countries to modify their air defence systems, with the result that there is an increasingly wide divergence between the various sectors of N.A.T.O. The same sort of thing will happen again tomorrow if some countries adopt the light fighter and others reject it. Having found it impossible to arrive at standardization with the present organization, N.A.T.O. authorities have fallen back on a demand for "compatibility" between the various types of equipment. It is obviously essential that a British fighter should be capable of employment in Turkey, or a French fighter in Norway. Great efforts have been made in this direction. But although cross-servicing is fortunately at last becoming a reality, and the difficulties due to language barriers have been more or less surmounted, there is a grave risk that, as more and more complex electronic equipment appears, we shall come up against very serious incompatibilities, unless all the countries which are working on these problems undertake to respect a minimum of common specifications. To take one example, automatic radio transmission systems from the ground to aircraft (or later to missiles) must be compatible if they are intended for universal use. Let us hope that the various countries will be able to come to some agreement . . . if not N.A.T.O. risks disaster.

Obviously the ideal is that all N.A.T.O. weapons should be standardized. All countries should submit a given item of equipment for contest, and the best should be selected. Production should then be carried out by one or more of the Alliance countries, each specializing in the branch for which its industry appears to be best suited. This would simultaneously solve both the technical and the industrial and social problems.

There is little ground for believing that this happy situation will be achieved within the near future. But let us hope at least that the problems of compatibility will be seriously tackled and solved.

Pooling resources

It might be thought at least that the Alliance would pool all its resources, both intellectual and financial. Alas, nothing of the kind has happened. Exchange of scientific and industrial information is still extremely rare, and many of the Commanders-in-Chief have bitterly complained about this state of affairs.



For example, the SHAPE Air Defense Technical Center at The Hague receives practically no information on the research carried out in this direction in the United States, Britain or France. It is hence very difficult for it to give any valid advice to the Supreme Commander.

In the missile field, as in that of atomic weapons, both of which are of major importance, each country works independently. At the best, the A.B.C. group within the Alliance (America, Britain, Canada) is accorded preferential treatment, and these countries exchange information which does not reach the others.

Yet the results recently obtained by the U.S.S.R. prove that all the brains in the West must work together to match our adversary's progress. If it is not possible to organize research on an international basis, the least that must be done is to set up a working central organization to collect all relevant information and disseminate it to countries requiring it.

The Command

"The inter-Allied Commands", writes General Servais, "have only very limited powers, at any rate in peacetime. In fact these Commands can do nothing without the consent and the cooperation of national governments and military staffs." He adds elsewhere, "In peacetime the inter-Allied Commands are essentially planning organizations. Real command could be exercised only in wartime. This is a serious handicap."

The various N.A.T.O. command levels, however high, have no real authority over their subordinates, unless the latter belong to the same country. In practice when a senior subordinate receives an important order from an inter-Allied commander, he reports on it via his national Staff to his Defence Ministry and does not obey the order unless the latter agrees. If he does not obtain his Minister's consent, he informs his inter-Allied commander of his objections . . . and the latter does nothing. What authority can a French general, for example, have over a "subordinate" British general when the latter is supported by his government, which pays him, controls his career and can withdraw him from his post at any time?

This weakness arising from the principle of national sovereignty leads to deplorable situations. Forces are moved by subordinates without the Commander-in-Chief even being notified. Major defence installations are set up directly by national forces without consulting any superior organization, and the senior commanders find themselves confronted with a *fait accompli* without being able to protest. As each country has different ideas of strategy, the mortal danger of such a system can well be imagined.

In the same way, when one of the higher organizations (SHAPE for example) wishes to reorganize it must first obtain the consent of all the great feudal lords. This is virtually a return to the principle of the *liberum veto* which, when applied in Poland, rapidly led to the downfall of that unhappy country. In fact, a number of reforms, though demanded by almost all the member nations, are blocked by the veto of a single member and therefore cannot be executed. One of the most urgent, for example, is the reorganization of the Allied tactical air forces which were originally set up to support the ground forces in a mobile war, but which are today outdated and entirely unsuited to their new tasks. What we must now be prepared for is a static ground battle as close as possible to the Iron Curtain, an air defence battle against the initial enemy attack and, finally and above all, an aerial counter-offensive which must carry the day. Many enlightened spirits think that the N.A.T.O. air forces should be reorganized along these lines to comprise, within each region, strategic air forces, air defence forces and finally reconnaissance and support forces. Although this reform has been under study for years, it is resisted by the partisans of the *status quo* and can make no progress.

The unwieldiness of the system

Quite apart from the major drawback that the N.A.T.O. generals have no real command authority in peacetime, the machine is devastatingly slow and unwieldy in operation, a feature against which General Gruenther, among other senior commanders, has repeatedly protested.

Let us examine, for example, the procedure for establishing a N.A.T.O. air base. It should be noted that air bases represent one of the few real successes of the system—at any rate in the practical field, although the basic thinking can be described as erroneous, since such bases are difficult to defend and highly vulnerable to atomic bombs.

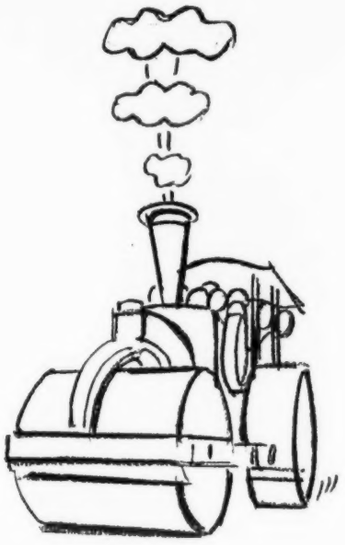
First of all the overall infrastructure programme must be prepared. The subordinate commanders draw up projects, and the Supreme Commanders coordinate plans after consulting the experts in the International Secretariat. The programme is then submitted to the Standing Group and the N.A.T.O. Council's Infrastructure Committee. The Standing Group passes on its comments to the Military Committee, and the final reports by the Military Committee and the Infrastructure Committee are then submitted to the Council, which in turn studies them.

If the project is approved, it must still be put into operation. Let us read what Lord Ismay says in his book "N.A.T.O.—The First Five Years".

"As soon as financial approval has been given, the full responsibility for construction rests with the host country. Its first duty is to determine the exact site for the airfield, the Military having indicated only the general area. The next step is to complete the blueprint for the airfield and to acquire the land on which it is to be built. When it is remembered that a standard N.A.T.O. airfield requires 1,100 acres and that this land is often owned by anything up to fifty different farmers, it will be realized that acquisition raises considerable financial, economic and social problems. So far as finance is concerned, the authorities in the host country have not only to purchase the land free of charge to N.A.T.O., but also in many cases to compensate the owner by the provision of alternative accommodation. However generous the purchase terms may be, the objections to uprooting a man whose family have owned the land for generations are obvious.

"While the acquisition of the necessary land is being arranged, engineers of the host country

draw up the master plan of the airfield. If it is a main airfield allocated for peacetime use, say, by the Royal Canadian Air Force or the United States Air Force, this master plan is drawn up in consultation with the Canadian or United States authorities in order that any special facilities which they require (and pay for) may be taken into account. The master plan is then sent to SHAPE for approval.



"When the plan has been approved the host nation authorities prepare a detailed cost estimate of the construction, which must be passed by the Payments and Progress Committee of the North Atlantic Council before funds are actually committed. It often happens that this Committee can suggest modifications to the plan which result in considerable financial saving. In almost all cases the next stage is for the host nation authorities to invite all N.A.T.O. nations to bid for the contract, and to notify delegations of opening and closing dates.

"Construction starts as soon as the contractor has been selected. When it is under way technicians from the International Staff, representatives of the Supreme Commander and of the user nation, visit the site and in due course submit progress reports to the Infrastructure Committee of the Council and to the Supreme Commander. As work proceeds, the host nation authorities send N.A.T.O. statements for the reimbursement of the money to be spent in the next quarter in accordance with the authorisation given by the Payments and Progress Committee. The money is then refunded according to the appropriate cost-sharing agreement.

"It may be thought that the planning and construction of infrastructure projects are unnecessarily complicated and lengthy. To a certain extent this has to be accepted because of the complexities of multilateral agreements and the need for most stringent economy. It must be borne in mind, first, that a large number of authorities are involved in almost every transaction—the host country, the user country, the North Atlantic Council (working through the Infrastructure Committee, the Payments and Progress Committee and the International Staff), the Standing Group, the Supreme Commander and the Subordinate Commanders: secondly, that the installations are generally highly technical and of considerable variety, and that they must in all respects be up to the standards required by the Military: thirdly, that installations have to be set up in twelve different European countries: and finally, that if N.A.T.O. is to get full value for money, the most thorough check and cross-check and the most drastic screening and pruning are essential at all stages."

The unwieldiness of the system lies not only in the number of links in the chain, but also in the slow pace at which each link works.

N.A.T.O. Staffs are all of the "integrated" type, that is to say they are composed of personnel from the various different countries covered by the Command concerned. Some of them (SHAPE for example) are also of the "combined" variety, because each section includes personnel from the Army, Navy and Air Force.

The first difficulty to be overcome is that of language. Although English tends to be the most widely used language, there are still many German, Italian and French officers in particular who do not speak it. Hence the need for double translation in all conferences which, unless done simultaneously, greatly slows down discussion and which in many cases is often inexact if not positively incorrect.

Secondly, N.A.T.O. has adopted the Anglo-Saxon system of committees which are composed of changing personnel and are difficult to assemble. These committees work methodically but slowly and must continue until they find solutions unanimously acceptable to their members. Such compromise solutions are rarely the best ones. What is more, there are many problems on which no compromise can be found! The committee then adjourns so as, in the standard phraseology "to allow its members to re-examine the matter". Meanwhile the secretary draws up a report, which is filed away with all the previous reports.

Finally, the system of integrated staffs involves the delicate task of sharing out key posts among the various nations. There is frequently a great deal of jockeying for these posts, and artificial promotions are often made in order to obtain them. At any rate the system leads to over-staffing and to a state of affairs where over-specialized officers are under-employed, and regard their tour of duty with N.A.T.O. as a period of study (not without its interesting aspects), unless they rapidly become disgusted and ask for a transfer when they see the small results of their efforts. The latter are very often the best officers!

Quite apart from the minor but real difficulties, such as those of translating and distributing documents, it has been found that many officers have considerable trouble in acquiring a true inter-Allied outlook. There are still too many, even today, whose reactions are marked by a regrettable nationalism, particularly when the Commander-in-Chief comes from their own country. To quote once again from the article by General Servais, "what hampers the action of the inter-Allied staffs and prevents them from giving of their best arises from a cause beyond their control. As has already been stressed, these large inter-Allied organizations can do nothing without the full collaboration of national authorities. But, parallel to the action which has led countries to draw closer together at the military level for the purposes of common defence, and to agree to relinquish certain prerogatives to this end, there has developed in the other direction a nationalistic reaction; nationalism based on distrust, with each country watching its neighbour for fear of doing more than its share; nationalism also inspired by concern for prestige, by national pride and emotional considerations.

"In this state of mind any constructive proposal for standardizing, unifying or strengthening arouses suspicion and provokes backstage wire pulling. Result: delays in, or even failure to arrive at concrete achievements, slowing down. A state of affairs due to the climate of peace where only immediate advantages are considered and the future is hypothetical. However, we must make the best of this situation, at any rate at the moment, since it would be vain in the present state of affairs to hope for anything better."

The remedy?

The picture we have just painted may appear black. Actually the N.A.T.O. organization is still in its infancy and may be considered as passing through its teething troubles. Present agreements leave the way open to numerous and far-reaching improvements. The improvements that could be made have become apparent during our examination of present defects.

The first thing to do is to combat the nationalist spirit and to create by every means in our power a real inter-Allied command. This could be done:

- by giving the N.A.T.O. chiefs real authority over their subordinates, both in peacetime and in wartime;
- by placing inter-Allied personnel entirely at the disposal of N.A.T.O. throughout their posting. During this period all personnel would receive the same pay, wear the same uniform and be answerable only to their inter-Allied chief who could reward or reprimand them;
- above all by abolishing the necessity for unanimity on every decision, both at the subordinate levels and in the Atlantic Council.

This obviously means asking countries to abandon the sacrosanct principle of total national sovereignty. But is not this the price of survival for the Alliance and thus of their own survival? Incidentally any country is always free to withdraw from the Alliance if it considers that its interests are not receiving sufficient attention.

Such surrender of sovereignty should be compensated by:

- supplying any member country who needs it with full information on the research carried out by all the others;
- giving each country posts on the inter-Allied Staffs in accordance with its defence contribution;
- an assurance that the most powerful countries will assist the less endowed nations to the utmost of their capacity and will support them politically and militarily in all circumstances.

Secondly, the present organization of the Staffs must be modified, their size cut down and their methods of work changed.

Finally, and perhaps above all, the nations must realize that this is not the moment to reduce their defence efforts, in a period of revolution in the art of war such as the world has never before experienced.

In the face of a monolithic adversary, with a single command, with high quality, widely varied but standardized equipment, with an immense manpower, all trained along the same principles and inspired by undeniable patriotism, our coalition would be courting defeat if our present deficiencies were not rapidly corrected.

More than ever unity has become the imperative for survival. But this unity must be real and effective. The time has come for some honest soul-searching, and the world is expecting great resolutions from N.A.T.O. Let us hope, for the sake of our future freedom, that they will be taken.

N.A.T.O.

Light Strike Fighters for the Defence of Europe

By General Pierre M. Gallois, Paris

From the moment it was decided that nuclear weapons might be used in the defence of Europe, a new problem arose, that of ensuring the "survival" of the flying equipment, or in other words of protecting the combat aircraft which would be the primary targets of hostile action.

In the age of the TNT explosive the threat to aircraft on the ground could be minimized by camouflage, local dispersion and the protection offered by blast bays. Such devices were widely used during World War II, with good results. Today they are no longer effective because of the extent of the damage which can be caused by a single atomic or thermonuclear warhead.

It is natural that under these conditions study of the protection of aircraft in the atomic age should have led to the consideration of entirely new principles, particularly as regards strike fighters, the very nature of whose task requires that they be stationed in the forward areas. These areas, already 200 to 300 miles in depth, are threatened by short range, and hence accurate, surface-to-surface missiles, against which no active defence measures can be employed. As further technical progress is made, the depth of the threatened areas will inevitably increase.

If conventional piloted aircraft must be stationed within such an area, their survival can be ensured only by virtually permanent mobility, that is by frequent transfers of the combat units from one base to another. Alternatively, protection could be afforded by organizing take-off and launching ramps or, better still, by a combination of the two methods. Yet another solution might be to abandon the system of grouping aircraft into combat units, or squadrons, in favour of the widest possible dispersion, even perhaps down to single aircraft. One advantage of this measure is that it would oblige an enemy to employ a very large number of missiles, but its disadvantage is that it would limit operational efficiency and above all would be very costly.

Needless to say, the policy of mobility can be considered only within the framework of a conflict in which nuclear projectiles would be used. All the studies so far made indicate that in such a conflict the period of massive destruction would be extremely short and that consequently a system of almost permanent mobility could well be applied, since it would be needed for only a few hours or perhaps a few days.

N.A.T.O.'s theories

The Supreme Commander, Allied Forces, Europe, has repeatedly stressed that the defence of Western Alliance territories is based on both the power to launch atomic reprisals against any aggressor (reprisals which would be the responsibility of the strategic units) and on the provision of ground forces to protect the territories of the Allied countries as far to the East as possible. The object is to halt any enemy occupation of these territories, whether by means of a massive thrust or by infiltration, while the two sides engage in atomic attacks aimed at destroying each other's sources of military power. In other words, the attacking ground forces must be held back until the effects of the atomic blows on the rear make themselves felt in the forward areas.

Basically the need is for relatively light aircraft with sufficient fire power to help the ground forces to hold out against a numerically superior enemy. The role of the light strike fighter units is thus to make it impossible for the enemy to concentrate his ground forces, in particular near the Allied lines of resistance, where the use of nuclear weapons would be dangerous to both sides.

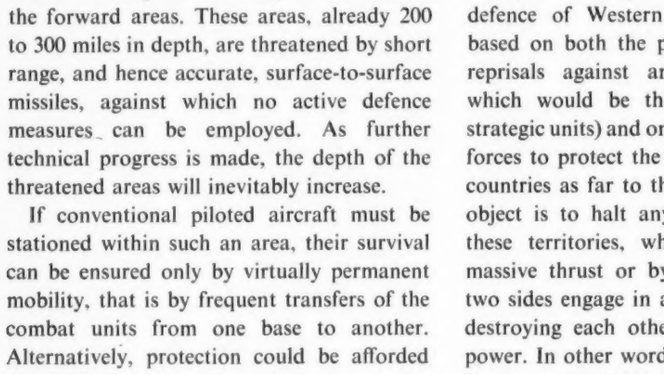
Is a piloted aircraft, particularly if equipped with conventional armament, necessary for the execution of this mission? Could it not be replaced by surface-to-surface missiles?

If weapons of great destructive power were to be used, the ground forces on both sides would seek their protection in dispersion and mobility. They would postpone concentrations until they were in contact with their opponents, that is until they had reached an area where the defenders could not attack them with atomic weapons without endangering their own units.

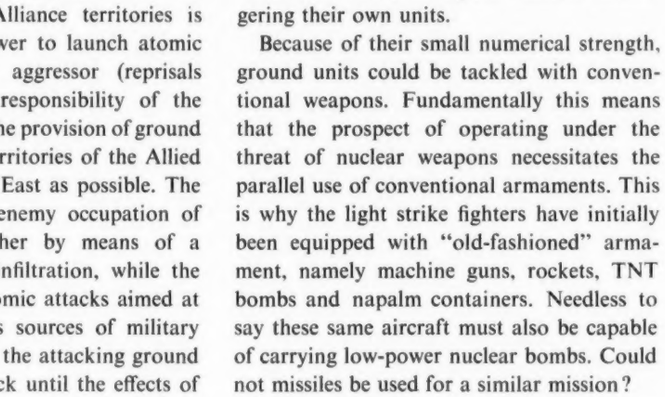
Because of their small numerical strength, ground units could be tackled with conventional weapons. Fundamentally this means that the prospect of operating under the threat of nuclear weapons necessitates the parallel use of conventional armaments. This is why the light strike fighters have initially been equipped with "old-fashioned" armament, namely machine guns, rockets, TNT bombs and napalm containers. Needless to say these same aircraft must also be capable of carrying low-power nuclear bombs. Could not missiles be used for a similar mission?

In the forward zone, surface-to-surface missiles hardly seem efficient except against

Fiat G.91 on the runway...



...with a wide variety of rapidly interchangeable ground support weapons.



Breguet 1001 *Taon*.

Sud-Aviation SE.5003 *Baroudeur*.

Dassault *Etendard VI* (N.A.T.O. version with Bristol *Orpheus*)...

...and *Etendard IV* (with SNECMA *Atar*).

static targets. True, it would be possible to envisage surface-to-surface missiles with so great a destructive power that they would indiscriminately destroy all targets within a given area. Use of such missiles however is restricted by their potential effects on the user's own forces. It would probably be wise to assume that the only deterrent to the use of high-power surface-to-surface missiles would arise from the fear of suffering from their indirect effects (radio activity). The latter danger, however, would probably be so great that only low and medium-power missiles could reasonably be expected to be used within the area bordering on the fighting line. In this case, a surface-to-surface missile with a low-power atomic warhead would be more effective against static targets than against dispersed and moving forces. Moreover, such missiles could not be launched without previous reconnaissance, and this would be one of the roles of the light strike fighter units. Because surface movements can today be made so rapidly, it might be difficult to use, for this task, heavy aircraft, stationed far away from the holding line selected by the defending side. This brings us back to the requirements which have led to the programme for a light combat aircraft.

The further our military studies of the possible utilization of high-power weapons advance, the clearer it becomes that it is virtually impossible to plan organized and centralized defence. The experts have realized that communications could be cut, populations reduced to panic, and chaos created in the most vulnerable zones. This might

A Test Pilot's Impressions

By Lieutenant Commander W.R. Hart, Royal Navy

From the point of view of the pilot, the N.A.T.O. trials held a great deal of interest both from the pure test flying involved, of which no test pilot can have too much, and also because they gave the opportunity to fly several foreign aircraft of advanced aerodynamic design from which much could be learnt of a technical nature. In addition a great deal could be gained by studying the test flying techniques of the other nations and in particular those of the U. S. Air Force and Navy. The United Kingdom contingent of one pilot and two technicians became part of the N.A.T.O. evaluation team with the blessing of the Air Ministry, although the philosophy of the light-weight strike fighter as a part of the defence of Great Britain had been rejected by the latter as being entirely inapplicable. For the period September 16th to October 5th, 1957, I therefore owed my allegiance to N.A.T.O. and was convinced at a very early stage of the value that this project could have in the defence of Western Europe.

The test programme compiled by the flight test sub-committee was framed in the broadest possible fashion and was in no way rigidly binding. Thus each team could plan their test programme in detail independently, and because of the inherent differences in test flying techniques, were able to present a final picture of much broader detail than would otherwise be possible. A bare minimum of three successful sorties of about 50 minutes each was considered necessary for the basic assessment on each aircraft. To do this required extremely careful pre-flight planning and no wasted flight time. From the pilot's point of view it was a great deal of hard work and no time left to admire the aircraft or the scenery. The final team reports were compiled almost entirely from pilots' qualitative impressions and with the minimum of data from special instrumentation.

Regarding the general organization of the evaluation, the results speak for themselves. To complete successfully five separate pre-view handling trials on prototype aircraft within three weeks under extremely variable weather conditions would reflect the utmost credit on any organization. To do so employing personnel from many different nations is little short of miraculous.

The terms of reference of the flight evaluation team were very limited, and our work was, of course, only a small part of the complete project. A great deal of work had gone on before, and no doubt there will be several months of wrangling ahead. We carried out the evaluation in order to assess each aircraft's stability, control and performance characteristics and to suggest means of improving any deficiencies. We did not list the aircraft 1st, 2nd or 3rd. The final choice of aircraft must involve factors about which we had no special knowledge, such as the cost of production; the time it will take to go into production; the ability to carry the chosen weapon or navigational equipment and even such small but important details as the ability of aircraft structure to stand up to the effects of gunfire. However, within its limited scope, I believe the results of the flight evaluation trials will be of immense value to the aircraft firms because they represent the views of a very broad section of test flying experience and should at least give an unbiased basis from which N.A.T.O. can make their final recommendation.

There were several very satisfactory features which became obvious during the course of the trials. Firstly the ability of the many nationalities involved to cooperate genuinely; secondly the technical skill and ability to work really hard displayed by all the aircraft firms and in particular the Breguet company who suffered much disappointment due to unserviceability; thirdly the efficient cooperation given by the Centre d'Essais en Vol at Brétigny and fourthly, I'm glad to say, the 100 percent reliability of the Bristol *Orpheus* and SNECMA *Atar* engines.

Finally, it was a great honour to work for Cdr. Schuld and the flight test sub-committee, and I hope that the determination which has brought the projects this far will not be betrayed in the future by apathy and petty bickering; two features which were noticeably absent during the flight evaluation trials.

rapidly lead to decentralized defence, to a kind of air and ground guerilla warfare conducted by very small but highly mobile units, each acting more or less independently. The light strike fighter is the most suitable category of air equipment for these particular combat conditions, especially if, taking advantage of its strictly defensive position, the Western coalition has properly equipped the territory it proposes to defend and has organized its logistic system so as to be as nearly invulnerable as possible to enemy atomic attack.

*

From the foregoing it is clear that the selected aircraft must have the following characteristics:

1. It must be capable of taking off from small fields, if possible from grass runways, so as to be independent of concrete runways, since these are static targets relatively easily destroyed by enemy surface-to-surface missiles. On the other hand, it must also be able to use existing airfields with concrete runways, as well as portions of roads or highways. It should not be forgotten that in the event of war a few projectiles would suffice to render even the biggest network of highways unfit for use by ground traffic, but that many portions of highway would remain and would be perfectly suitable for use as runways by light combat aircraft.

2. It must carry extensive conventional armament, and perhaps low-power nuclear armament suitable for use in the forward area.

3. It must be so designed that rearming and refuelling operations can be carried out very rapidly, so that light strike fighter units do not present too vulnerable a target by remaining long on the ground.

These were the considerations behind N.A.T.O.'s programme for light strike fighters, as prepared at the beginning of 1954.

Needs of European defence

A large percentage of the combat aircraft in service in Western Europe have been supplied by the United States under the Mutual Defense Assistance Program. These aircraft are today approaching obsolescence and must gradually be replaced.

In view of the changes in defence strategy, it seems likely that they will be replaced by two categories of equipment, one *heavier* and the other *lighter*. The first will probably be responsible for destroying enemy bases and launching sites, and the other for direct support of the ground forces in their holding battle. The programme for the light strike fighter is designed to fill the latter need. Several hundred of these aircraft will be required for this form of defence in Western Europe.

The Bristol Orpheus and the N.A.T.O. Light-Weight Strike Fighter Programme

By B.S. Massey, Assistant Chief Designer, Bristol Aero-Engines Ltd.

The performance of the *Orpheus* engine at the N.A.T.O. light-weight strike fighter trials, which took place at Brétigny in September and October, was in a sense the reward for the many hours of thought which had gone into the design and development of the engine. It was also the sequel to a happy relationship between the firms of three different countries. The trials afforded a striking illustration of the international cooperation possible under the N.A.T.O. alliance.

Design of the *Orpheus* engine began at the end of 1953, and the first run took place on the test bench in December of the following year. It satisfactorily completed its first type test in May 1955. Meanwhile, SHAPE had issued a requirement for a light-weight strike fighter, resulting in a design competition. Almost all the entrants in this competition specified the *Orpheus*, which thus became the logical choice of engine for development to power the N.A.T.O. light-weight strike fighters.

Altogether three aircraft, the Fiat G. 91, the Breguet *Taon* and the Dassault *Etendard VI* were selected for development, which was to be carried out under the auspices of the Mutual Weapons Development Programme. Bristol Aero-Engines was asked to work together with these three firms to achieve the maximum degree of standardization of equipment, particularly with regard to engine-driven accessories. A thrust of 4,850 lb. (2,200 kg) was specified as the figure required for these aircraft, and a type test of the BOr. 3 at this rating was successfully completed in May 1957.

Because of the relatively short flying time of the prototype aircraft before the Brétigny trials commenced, there might have been some cause for trepidation as to how the various engine/airframe combinations would perform. In actual fact, the degree of unserviceability during the three-week period was remarkably small, and no engine changes attributable to engine faults were found necessary.

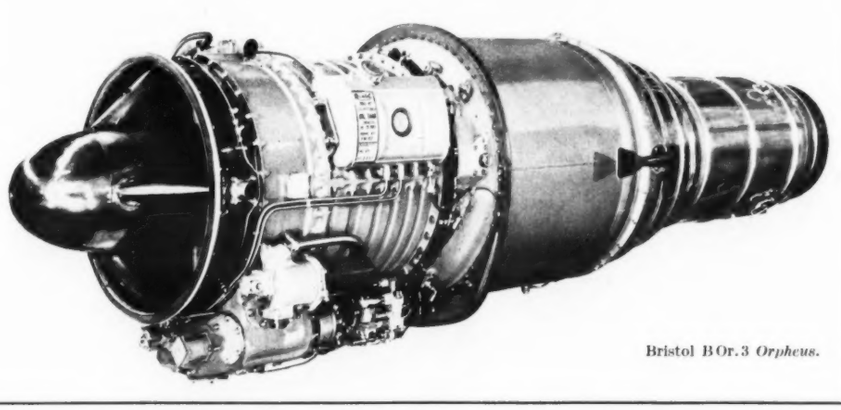
The total amount of flying carried out during the period of the trials—the aircraft averaged two flights a day over the entire three-week period—was a demonstration of the reliability and good basic design of the engine and its installation. Certain days were set aside for demonstrations of engine changing, aircraft component changes and maintenance drill, so that the aircraft flew three and sometimes five sorties on subsequent days to maintain the average quoted above. Comment on the handling of the engine was very favourable, the ease and rapidity of starting being particularly remarked upon.

The advanced versions of the *Orpheus* which are being developed by Bristol Aero-Engines are the 5,760 lb. thrust *BOr. 11* and the 6,810 lb. thrust *BOr. 12*. This latter engine, with light-weight reheat, will give 8,000 lb. (3,630 kg) thrust for take-off. These engines are both expected to have a higher thrust/weight ratio than the current BOr. 3, which itself achieved the highest figure for any type-tested engine; and, moreover, the specific fuel consumption of the two advanced versions will be lower than that of the *Orpheus BOr. 3*. The *BOr. 11* and *BOr. 12* are successive developments from the *BOr. 3* and, for installation in N.A.T.O. aircraft, will meet the same requirements for accessories and aircraft services.

The existence of a development contract for these advanced versions was revealed some time ago. Just as the development of the current engine was authorized before the aircraft, in order to allow time for the engine to be developed to flight standard prior to the first flight of the aircraft, so, once again, the Mutual Weapons Development Team have wisely sponsored further development of the engine ahead of any decision on the aircraft. The timing of future developments on the aircraft side is of course dependent on N.A.T.O. policy on the light-weight strike fighter, which is no doubt under review as a result of the trials.

The short take-off run of the *Orpheus*-powered aircraft would be still further improved by the fitting of a more powerful engine, and in fact not only have design studies been prepared of the application of the *BOr. 12* to the three aircraft specifically developed for N.A.T.O., the Fiat G. 91, Breguet *Taon* and Dassault *Etendard VI*, but similar design work has also been carried out in respect of the application of the *BOr. 12* to the *Etendard IV* and the Sud Aviation *Baroudeur*. It is inevitable that some degree of airframe redesign will be required in order to accommodate an advanced model of the *Orpheus*, the length of which is slightly greater than that of the *BOr. 3*. However, this redesign should be a minimum, as the overall diameter of the engine remains unchanged.

All three aircraft manufacturers have announced that two-seat versions of their respective models are contemplated for training purposes, and that these aircraft will be capable of operational use. At Bristol the development of the *Orpheus* continues at full pressure, and we look forward confidently to the day when the engine will enter squadron service, a worthy defender of the heritage of Western Europe.



Bristol BOr.3 *Orpheus*.

Approximate data for the light strike fighters demonstrated at Brétigny*, and their projected developments

Type	Fiat * *G.91*	Fiat *G.91A*	Fiat *G.91S*	Breguet * *Taon*	Breguet *Taon*	Dassault * *Etendard VI*	Dassault *Etendard VI*	Sud-Aviation * *Baroudeur*	Dassault * *Etendard IV*
Power unit	*Orpheus 3*	*Orpheus 3*	*Orpheus 12*	*Orpheus 3*	*Orpheus 12*	*Orpheus 3*	*Orpheus 12*	*Atar E-4*	*Atar E-3*
Max. static thrust (lb.)	4,850	4,850	6,800	4,850	6,800	4,850	6,800	8,160	8,160
Span (ft.)	28′ 2″	29′ 6″	28′ 2″	22′ 4″	25′ 7″	26′ 11″	27′ 10″	32′ 10″	31′ 6″
Wing area (sq. ft.)	ca. 177	ca. 194	ca. 215	ca. 156	ca. 215	ca. 226	ca. 270	ca. 270	ca. 270
Angle of sweep at 25% chord	37°	37°	38°	43°	43°	45°	45°	35°	45
Thickness/chord ratio (%)	10	9	8	6	6	6	5	8	6
Normal gross weight (lb.)	ca. 10,360	ca. 11,240	—	—	—	—	ca. 13,670	ca. 13,580	—
Increased gross weight (lb.) (with external loads)	ca. 11,460	ca. 12,360	ca. 12,790	ca. 11,450	ca. 13,000	ca. 12,360	ca. 15,760	ca. 15,000	ca. 14,300
Max. Mach number, level [1]	ca. 0.92	ca. 0.92	ca. 0.94	ca. 0.95	> 1.0	—	> 1.0	ca. 0.98	> 1.0
Penetration depth [2] (n.m.)	ca. 150	ca. 185	—	ca. 150	—	ca. 150	—	—	—
Take-off distance to 50′ (ft.) (with normal gross weight)	ca. 2,800	ca. 2,300	—	ca. 3,600	—	—	—	ca. 3,900	—
from	Concrete [3]	Concrete [3]	—	Concrete [3]	—	—	—	Grass	—
Equipment	Ejection seat Pressure cabin	Ejection seat Pressure cabin	Ejection seat Pressure cabin	Ejection seat Pressure cabin	Ejection seat Pressure cabin	Ejection seat Unpressurized	Ejection seat Pressure cabin	Ejection seat Pressure cabin	Ejection seat Pressure cabin

Remarks: 1. Mach 1 corresponds to a max. speed of 665 knots at +15 °C ambient temperature, or 645 knots at 0 °C; 2. Penetration depth at an altitude of approx. 3,000′ for 30 % of the mission at max. speed, remainder at a cruising speed of 300 to 350 knots; 3. Appropriately longer take-off distances are needed on grass fields; 4. All aircraft can be armed with either four .5-in. machine guns (300 rounds each) or two 30-mm-cannon (120 rounds each) and can also carry bombs or napalm containers, as well as guided or unguided rockets.

The inter-Allied programme was therefore based on the following points:

1. In order to arrive at a suitable aircraft, the usual compromise between conflicting characteristics was slanted towards take-off from roughly prepared fields and towards the requirements of low altitude combat.

2. Because of the special conditions under which these aircraft will be used, it was possible to reduce their complexity, their weight and consequently their cost.

3. The formation of units equipped with these light strike fighters would make it possible to create a new logistics system in the event of war and a special deployment system in peacetime. In this way the air forces deployed in the forward areas would become less vulnerable to atomic blows and would have a good chance of survival.

History of the project

As soon as the N.A.T.O. programme was made known, a number of manufacturers worked out projects to these specifications and passed them on to their respective governments for study by the appropriate N.A.T.O. organs. A special committee was set up under the chairmanship of Professor von Kármán, which sat at the Palais de Chaillot during the first half of 1954 to examine the projects submitted.

Finally, the proposals put forward by Breguet, Fiat and Dassault were selected for award of a prototype contract, which was financed to a large extent with the aid of American funds provided by the Mutual Weapons Development Team, supplemented by national appropriations.

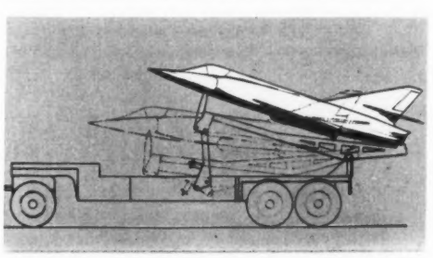
As regards the powerplant, it was agreed that a new jet engine, designed with due regard for the latest technical advances, should be used. The engine chosen and ordered to equip the various prototypes was the Bristol *Orpheus*.

During 1955 and 1956 the staff of the Supreme Allied Commander, Europe studied the conditions of employment for these aircraft. At the end of 1956 it sent a group of military and technical experts to the various N.A.T.O. countries to explain the operational considerations which led to the light strike fighter programme and to acquaint them with the projects selected.

The prototypes ordered by N.A.T.O. underwent their flight testing during 1956. All these aircraft have been watched since the outset by a special committee set up within N.A.T.O., which has been in operation uninterruptedly for the past two years. This committee controls a number of sub-committees whose task it is to follow such aspects as accessories, armament, future developments, etc.

It will be recalled that the N.A.T.O. programme originally specified a take-off weight in the range of 8,000 to 10,000 lbs., and that the engine thrust required to enable the aircraft to take off in short distances was laid down as 4,800 to 5,000 lbs. As has so often happened in the past, take-off weight increased regularly during the design and manufacturing stages of the aircraft for the N.A.T.O. programme. About mid-1956, therefore, a parallel increase in the power of the engine chosen for the aircraft was found to be necessary. Bristol then proposed use of the *Orpheus 12*, a development of the *Orpheus 3*, with a thrust of 8,000 lbs. (with reheat). This restored the thrust/weight ratio originally envisaged.

Drawing of the mobile take-off ramp for the Dassault *Etendard VI* fitted to a heavy road trailer.



During September 1957, a group of American, British, Italian and French pilots, headed by Lieutenant Commander Schuld of the U.S. Navy, proceeded to evaluate the flying qualities of the aircraft considered likely to meet S.H.A.P.E. requirements. The tests were followed by Professor von Kármán on the one hand and Colonel Chapman, head of the air section of the Mutual Weapons Development Team, on the other. Finally the reports prepared by the test pilots were assembled, and an overall evaluation made by France's Brigadier General Brohon, of S.H.A.P.E., for submission to the Supreme Commander and other senior departments of the inter-Allied organization.

*

A decision will be made soon. When it comes to financing these aircraft, two methods could be applied. Bilateral agreements might be concluded between the countries concerned and the United States, which would mean a virtual return to the policy of off-shore orders; or the same principles could be applied to the financing of the light strike fighter as permitted the construction of the powerful infrastructure now available to N.A.T.O. Under the latter scheme, each country would pay a certain proportion, based on its national income and on its needs, towards the cost of the aircraft required for the coalition as a whole. This method would have the advantage of forming a common fund and making it easier to agree on a single prototype for production. This in turn would lead automatically to standardization of the equipment employed.

Meanwhile N.A.T.O. experts are carefully studying these possibilities, so that the hopes placed in the inter-Allied project can be materialized at an early date.

The Four Manufacturers' Views

Interviews with Interavia's Rome and Paris Correspondents

The idea of providing for the European N.A.T.O. air forces a lightweight, economical and, if possible, standard strike fighter goes back to 1953. After several designs for aircraft in this category had been worked out in conjunction with the Advisory Group on Aeronautical Research and Development under Dr. von Kármán, and SHAPE had approved the strike fighter project in principle, the Pentagon announced in 1954 that it was prepared to provide a first sum of $ 10,000,000 for development purposes.

By 1957 the aircraft developed by three European manufacturers—Fiat of Turin, Breguet and Marcel Dassault of Paris—were ready for comparative technical and flying tests. The French firm of Sud-Aviation also decided to enter its *Baroudeur* as an "outsider" in the contest, which took place at Brétigny Test Centre near Paris at the end of September 1957.

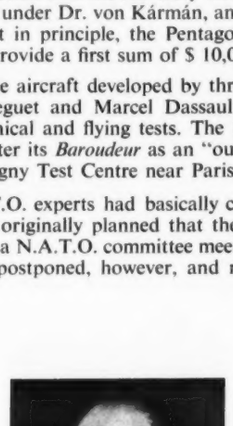
The N.A.T.O. experts had basically completed their work, and theoretically it was originally planned that the results of the contest should be announced at a N.A.T.O. committee meeting on November 12th, 1957. The meeting was postponed, however, and negotiations, on which no details have so far been published, took place between Washington and the European authorities concerned.

The first rumours to circulate suggested that the N.A.T.O. experts had been particularly favourably impressed by Italy's Fiat G.91, and were recommending its production. However, the French are reported to have raised objections, a move which still leaves the final decision uncertain.

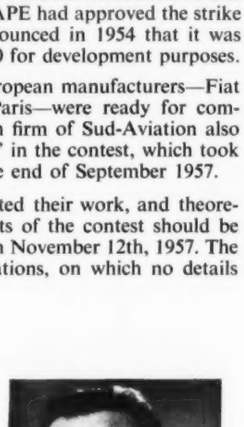
It is not for the Editors to express any opinion on the pros and cons of the various aircraft. They have preferred to ask each of the manufacturers in turn the same questions and to leave the reader to form his own opinion.

The questions were put to:

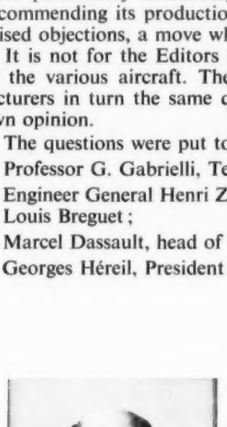
- Professor G. Gabrielli, Technical Director of Fiat Aviazione;
- Engineer General Henri Ziegler, Managing Director, Ateliers d'Aviation Louis Breguet;
- Marcel Dassault, head of Général Aéronautique Marcel Dassault;
- Georges Héreil, President and Managing Director of Sud-Aviation.



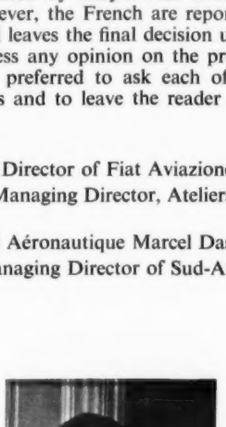
G. Gabrielli



H. Ziegler



M. Dassault



G. Héreil

INTERAVIA: The reasoning behind the light strike fighter programme has been under discussion for some time in Allied air force circles. From what we know, opinions seem to be divided. What do you think of the combat value of these aircraft, supposing that they were ordered in large numbers?

G. GABRIELLI: We believe that the light strike fighter fills a gap in Europe's present arsenal of weapons systems and that it fully meets the needs on which its specification was based. Our G.91 is an economical aircraft in both first cost and operation, and can therefore be used in quantity; moreover it needs only a minimum ground organization. Hastily prepared strips a few hundred yards in length are sufficient, thus doing away with the need for costly and vulnerable fixed installations. The aircraft can carry powerful and varied armament, which can be modified to suit the target during the few minutes taken up for refuelling. For this reason the G.91 is the ideal instrument for clearing a path for the ground forces and hampering the aggressor through the systematic destruction of his forces and his supply system in the strip of territory behind his lines where no other equipment can be used efficiently to detect and strike small mobile targets.

H. ZIEGLER: The light strike fighter programme is based on specifications which differ radically from the traditional concept of conventional fighters. The latter have been developed to attain increasingly high performance in the supersonic range and at high altitudes, but require highly organized bases with very long runways. The basic specification for the light strike fighter calls for an aircraft capable of taking off from short, unprepared fields. As technical developments advance, more and more attention will be given to this capability. In this respect the light strike fighter programme will revolutionize the use of air units in direct support of the ground forces.

M. DASSAULT: The SHAPE specification is the result of the organization's study of the new conditions which would prevail in a conflict where nuclear weapons were used. The use of hastily prepared runways, the need for mobility in strike fighter units and for reducing unproductive time spent on the ground in refuelling and rearming these aircraft are new requirements to which the engineer must give his full attention and to which he must find technical solutions. I am sure that the efforts that have been made in this direction during the past three years will not have been in vain and that they will open the way to new solutions. The military reasoning behind the programme cannot be discussed here. What is important is that the aircraft manufacturer should adapt himself to this reasoning and meet the requirements of the military command.

G. HÉREIL: War is always a costly affair. We must therefore show the greatest ingenuity in adapting technical advances to military needs in the most economical manner. However, military needs are also constantly changing, both because of changes in the international situation and because of rapid advances in engineering. As regards the light strike fighter, it is logical to insist on a highly specialized aircraft which can maintain its operational qualities despite enemy action against air bases. Though opinions were originally more or less equally divided, the number of supporters of a lighter type of fighter has since increased. We must find the happy mean between an aircraft too light to be efficient and an aircraft too heavy to be used to the best advantage on more than a small percentage of its missions. The heavy aircraft may well have advantages for certain missions, but these do not outweigh its disadvantages—not only financial—in all other cases. A substantial contract providing a single aircraft type for use by all N.A.T.O. countries would be a logical measure well in line with the demand for standardization in armament and integration of the European forces.

INTERAVIA: As a manufacturer, do you consider that the SHAPE specifications raise difficult technical problems? Or do you feel that, in today's state of the art, you have sufficient resources and knowledge (suitable power unit, equipment, low speed aerodynamics, etc.) to meet the programme?

G. GABRIELLI: The specifications of the N.A.T.O. programme undoubtedly entail serious difficulties. Although adequate resources were available to solve the problems, the difficulty in this particular case lay essentially in the need to combine harmoniously so many diverse characteristics, some of them contradictory. The result had to be an extremely compact air-

craft (or one fitted with "maximum density" equipment) if, despite its small dimensions compared with those of the conventional fighter, it was to be reliable in operation and offer the pilot the necessary degree of comfort. It will suffice to recall that this fighter had to be light, but powerfully armed and armour-plated, carry complete instrumentation and equipment and be manoeuvrable and easy to fly: it had to have excellent flying qualities throughout the speed range, from the lowest up to supersonic speeds; it had to be robust and be capable of taking off and landing on small makeshift fields; it had to carry a sufficient volume of fuel to execute the typical missions listed in the programme and finally—which helped to increase the difficulty of all the other problems—its cost had to be kept within relatively modest limits.

H. ZIEGLER: The technical problems involved are undoubtedly difficult. Nevertheless, the specifications have been met, thanks to persistent efforts, and we are confident that we can achieve substantial improvements in the future. Increasing power/weight ratio and operating reliability are permanent features of aeronautical design. The Bristol *Orpheus* is already an outstanding achievement and is capable of substantial future development. The combination of very high aerodynamic qualities at low speed with fully adequate aerodynamic qualities at sonic speeds also presented a particularly difficult problem.

M. DASSAULT: In view of the performance to be obtained and the military loads to be carried, the characteristics of the power unit selected are the deciding factor. It will be easier to meet the military requirements of the programme now that there is available a power unit with at least the static thrust of the Bristol *Orpheus 12*, which the N.A.T.O. experts have so rightly substituted for the *Orpheus 3*. This is why, as soon as the specifications became known, I decided upon an airframe capable of taking a more powerful engine and thus of benefiting from the higher and higher thrust engines which are always developed from a new high quality jet.

G. HÉREIL: The initial restriction on gross weight was not realistic in view of the other specifications. It is certain that the more advanced version of the *Orpheus* will facilitate the manufacturer's task, in so far as it proves superior from the point of view of cost and consumption.

INTERAVIA: Could you tell us on what basic considerations you designed your light strike fighter? Every aircraft is the result of a number of compromises; which compromises did you accept in order to arrive at the aircraft presented to the inter-Allied team of pilots last September?

G. GABRIELLI: The only compromises accepted in the G.91 are those which have been necessary in order to balance so many different characteristics. None of the specifications has been deliberately ignored. As the aim was to produce a simple aircraft, so as to facilitate maintenance and hence utilization, our engineers endeavoured to obtain the best combination of all the qualities demanded, basing their efforts on the principle that the defence of the free world needs aircraft which are fully equal to the conditions under which they are required to operate. The G.91 is designed to support the ground forces; it is therefore pointless, or even harmful, to try to make it into an interceptor or a long-range fighter-bomber, to the detriment of the characteristics essential for its tactical utilization.

H. ZIEGLER: The Breguet *Taon* is the result of a two-fold effort, directed at both aerodynamic qualities and structural design. The aerodynamic formula, selected after extensive study, is outstanding as regards lift and manoeuvrability at low speeds. Yet flying qualities in the sonic range also present no problems. These results have been obtained as a result of long experience and the technical assistance provided by American experts. From the structural point of view, the use of composite materials combines great weight-saving advantages with ease of manufacture. The resulting aircraft lends itself particularly well to production on a pan-European scale.

M. DASSAULT: The two main requirements in SHAPE's programme seem to me to be the ability to use hastily prepared runways, or even sections of roads and highways, on the one hand, and maximum speed near the ground on the other. I believe in speed for a combat aircraft. In aeronuclear warfare we cannot expect light fighters to be protected by faster aircraft, and the light strike fighter must have sufficient speed to escape both ground defences and enemy fighters. The *Etendard IV*, making its get-away at low altitude, can easily out-fly an aircraft such as the F-100. The aircraft of the *Etendard* family combine a high load factor with a high Mach number, the latter near the ground, of course, since this is the operational domain of this category of aircraft. The problem of survival on the ground will be solved by the use of makeshift airstrips and above all by take-off from ramps, for which application the *Etendards* have been specially designed.

G. HÉREIL: Our *Baroudeur* was designed before the aircraft for the N.A.T.O. programme and before the programme itself was prepared. It is fitted with an *Atar* jet, and two main considerations guided its design: a) to produce a *really* all-terrain aircraft; an aircraft designed for combat, not just for showing off on the ground; b) to achieve the greatest possible manoeuvrability at low altitudes. Everything else had to give way to these two requirements.

INTERAVIA: Will the design which you have prepared for a light strike fighter also be suitable for other missions—day fighter, all-weather fighter or armed reconnaissance missions for example—and if so under what conditions?

G. GABRIELLI: My foregoing reply also partly applies here. We would merely add that there is no point in deluding ourselves; we have entered an age in which interceptors are being outclassed by missiles. An aircraft of the light strike fighter formula cannot aspire systematically to play the role of interceptor or all-weather fighter. Within these limitations, the G.91, with its machine guns, cannon and air-to-air rockets, and thanks also to its outstanding manoeuvrability, is capable of defending itself vigorously against any enemy aircraft; it might also be able to execute local interception missions.

A special version, the G.91 R, is planned for armed reconnaissance, for which its good manoeuvrability at low speeds, excellent protection against ground arms, powerful armament and carefully arranged cameras make it highly suitable.

H. ZIEGLER: Although the light strike fighter with heavy fire power has been designed primarily for direct support of the ground forces, its major role may well be the tactical reconnaissance essential for both the operations of the ground forces and the use of medium-range missiles.

M. DASSAULT: Priority was given to meeting the programme. Anything which did not help in this direction was eliminated. It so happens, however, that the *Etendards* could also be used for fighter operations at low and medium altitudes. Speeds of Mach 1.4 have been achieved, and the design of the fuselage nose enables an all-weather electronic fire control system, also developed by my company, to be carried.

G. HÉREIL: Considerations of economy and standardization justify the additional use of the strike fighter for armed reconnaissance and day fighter missions at low altitude. This is also possible from the manufacturing point of view, by incorporating modifications, such as the addition of auxiliary tanks, in the basic aircraft.

INTERAVIA: Did you have any special problems to overcome in designing and building your aircraft?

G. GABRIELLI: Among the special problems which had to be solved in designing the G.91 was the need to ensure a capability for operation from grass fields or hastily prepared runways and for take-off and landing over short distances. The excellent results achieved can be attributed to the aircraft's following technical features: a) minimum airframe weight and adoption of the low-wing configuration, which enabled undercarriage weight to be reduced and produced a lift-increasing ground effect; b) maximum efficiency of the undercarriage, thanks to the use of an articulated fork not only for the nose wheel but also for the two main units. This system, which enables horizontal stresses to be absorbed, gives the undercarriage a high degree of elasticity. During the technical tests held at Brétigny, the G.91 effectively demonstrated that it could be used without difficulty on semi-prepared fields at full load and with two 250 kg bombs beneath the wings.

H. ZIEGLER: Among the special problems solved in building this machine, I would mention primarily the application of the area rule and the difficult problem of controls, both of which necessitated use of very advanced techniques.

M. DASSAULT: Every aircraft formula raises new problems. But the relatively large number of prototypes already developed and above all the experience acquired in the quantity production of the *Ouragan*, *Mystère* and *Super Mystère* facilitated the task of my design offices. New technical compromises did have to be envisaged, but most of them had already been investigated or put into practice by the company's engineers, which again facilitated their task.

G. HÉREIL: The aircraft skid and trolley system, which enables unprepared fields to be used, was essentially new. However, the design of the aircraft was so successful that in the majority of cases there is no need to use the trolley, as the large number of tests carried out both before and during the contest have amply proved. The wide speed range required raised very difficult problems as regards lateral stability. The need to carry the maximum external load imposed restrictions on ground clearance and position of the fin unit. All these problems have been solved with good success, and the *Barouder* is still the only transonic aircraft which has landed and taken off on the beach at La Baule.

INTERAVIA: You have obviously already given some thought to the question of large-scale production of your design. Supposing that a substantial order were placed early this year, do you think that production could begin rapidly?

G. GABRIELLI: In the case of the G.91, we determined *from the outset* to design an aircraft capable of rapid and easy production. Fiat is already tooled up for quantity production, and a simple reorganization of equipment and personnel (already trained) would suffice to get the G.91 into production. The aircraft could be turned out in large numbers without delay after the pre-production batch now being built.

H. ZIEGLER: Production in large quantity was one of the basic aims in the design of the *Taon*, as I indicated when talking of the type of structure adopted. Production could begin immediately and would not necessitate use of very complicated milling machines (which need to be ordered well in advance), such as are required for so-called integral structures.

M. DASSAULT: I have already replied in part to this question. At Générale Aéronautique Marcel Dassault every prototype is designed with a view to quantity production. Large-scale production could be launched rapidly since, as you know, the French Navy has chosen the "navalized" version of the *Etendard IV*, and preparations have already been made to start a production line. What is more, the type of construction chosen will be suitable for quantity production in Europe, using techniques and machine tools in common use on this side of the Atlantic.

G. HÉREIL: From the outset the design of the aircraft was split up into interchangeable assemblies, to enable it to be produced in different factories. Existing tooling is adequate to permit the almost immediate production of a first batch. Exact production dates would be determined by the supply question.

INTERAVIA: N.A.T.O. is an inter-Allied organization. The prototypes of these aircraft have been financed on a bilateral basis, between the United States on the one hand and the manufacturing country on the other. Do you think that the aircraft finally selected could be produced on a communal basis, and if so how do you suggest that work should be distributed?

G. GABRIELLI: The defence of the free world is so important that it overshadows the personal interests of any one company or any one country. In view of the large number of aircraft to be built and the relatively short time available, it will be essential to take maximum advantage of the European production potential. What is more, large-scale production would reduce the unit cost and hence the financial burden for the countries purchasing the aircraft. Quite apart from technical and operational considerations, this is yet another reason for producing a single aircraft type in all the countries concerned, rather than several different types. Under these conditions, I think that a distribution of the work between the various N.A.T.O. countries would be within the spirit of the light strike fighter programme.

H. ZIEGLER: Joint production of the light strike fighter would appear to be a logical outcome of the concept. Breguet, for example, has already concluded a series of industrial agreements in Europe, which would greatly facilitate the launching of coordinated production.

M. DASSAULT: The Technical and Industrial Directorate of France's Secretariat of State for Air could reply to this question better than I can. As you know, Dassault has built some 1,200 combat aircraft in close collaboration with other French manufacturers. The method is a successful one since, for example, the *Mystère IVAs* ordered under off-shore contracts were built and delivered in record time, although manufacture was split up among a number of companies with widely dispersed plants. There would be no difficulty in including a number of aircraft manufacturers from Allied countries in this scheme. Incidentally, an agreement of this kind has already been concluded with Fiat, with the approval of the French Secretary of State for Air.

G. HÉREIL: The *Baroudeur* was financed by my company for a long time without any outside support. However, my company has always expressed and put into practice very liberal views on the European level. It would therefore be in full agreement with European production of the aircraft selected, for technical, psychological and financial reasons. The dominant principle in distributing the work would have to be that of appointing a *single main contractor*, responsible for the *whole* of the contract. Our relations with other European manufacturers within AICMA are such that there would not be the slightest difficulty in sharing out the work.

INTERAVIA: Do you think that production will be financed jointly by all the countries concerned, or will there be merely bilateral agreements between the United States and the purchasing country? Which would be the better solution from the industrial point of view?

G. GABRIELLI: To discuss now the financing conditions would be presuming on events. It is very difficult to present any but a personal view of the subject. However, it would be possible to envisage a bilateral system between manufacturers and purchasers, with the financial support of the United States, who would play the role of "freedom bank" in the interests of common defence, in cases where a country were not in a position, at any rate immediately, to finance its share of light strike fighters. The United States could underwrite a certain output in the Allied countries, and the funds advanced could subsequently be deducted from American aid credits to the Allies.

H. ZIEGLER: Coordinated financing is in a sense a natural corollary to coordinated production. The light strike fighter is a weapons system which, in its conception, production and financing, should be the result of a collective and coordinated effort by the N.A.T.O. countries.

M. DASSAULT: The off-shore system was particularly efficient on the bilateral level. I know that N.A.T.O.'s ground organization was financed from a common fund, and that this method has also been successful. If applied to aircraft manufacture, it would have the advantage of encouraging the best form of standardization, namely standardization at source through the adoption and manufacture of the smallest possible number of aircraft types.

G. HÉREIL: Communal financing is the most reasonable solution. The need would be to find a balance between the financial contribution of each country and the value of its share in production.

INTERAVIA: The configuration which has just been developed for take-off from short runways is merely the first stage in a new trend. Have you other projects, based on the same requirements, which will be a substantial advance on the present designs?

G. GABRIELLI: Several different wing units are being built (incorporating, for example, a leading edge high-lift flap and a slight increase in area); they are designed to improve still further the G.91's take-off and landing qualities (which proved at Brétigny to be well within the limits laid down for the contest). The new wing variants will entail practically no modifications to installations or performance. The new aircraft version, known as the G.91A, is probably the one which will be produced in quantity immediately; it is fitted with the same engine as the G.91, namely the Bristol *Orpheus BOr.3*. The G.91A is not a new aircraft, but is based on the experience gained with the G.91. Fuel capacity will be increased, which will prolong the radius of action on a typical mission by 35 miles. My company is also working on a project for a version of the G.91 capable of being launched from a ramp. A later model is envisaged, the G.91S, which will be powered by the Bristol *Orpheus BOr.12*.

H. ZIEGLER: The light strike fighter formula is merely a beginning which will obviously be followed up. Continuing technical advances will lead to substantial improvements as regards facility of employment on the tactical level.

M. DASSAULT: Of course. What manufacturer is not working on tomorrow's needs?

G. HÉREIL: The planned stages all follow a logical line of development: firstly, very much more efficient, though conventional, high-lift devices, then use of the jet engine to increase lift or even to provide full lift, and finally, when flight in the neighbourhood of stalling speed has become sufficiently safe, transfer to pure VTO without sacrificing the high performance achieved.

INTERAVIA: Do you not think that, despite the growing encroachment of missiles of all kinds, ground attack missions will require manned aircraft for a longer time to come than other missions? For how many years do you think the manned strike fighter will be needed?

G. GABRIELLI: The whole N.A.T.O. light strike fighter programme was based on the assumption, accepted after mature consideration, that a piloted aircraft will be needed for a long time to come for strike missions against ground targets in the territory directly occupied by enemy troops where no other methods can be used satisfactorily for the detection and destruction of small, mobile targets.

H. ZIEGLER: Because of the dispersion and mobility of the targets and their camouflage, tactical missions will definitely and permanently require the presence of the human brain and eye. Just as interception or long-range reprisal missions against known, fixed targets require performance beyond human capacity, tactical aircraft cannot be imagined without a crew.

M. DASSAULT: There can be no doubt that the surface-to-surface missile is not well suited for the missions now allocated to light strike fighters. Surface-to-surface missiles cannot yet "see" their targets and cannot hit them if they are mobile and dispersed. That is, unless the missile batteries receive information from reconnaissance aircraft—and this is one of the most important roles which N.A.T.O.'s light aircraft will have to fulfil. We have given very close attention to the reconnaissance versions of the *Etendard*, since they meet a need which will be felt for many years to come.

G. HÉREIL: My answer is yes. It was because I was convinced that the ground support fighter had the greatest future of any manned aircraft that I chose this category when I decided, despite the fact that construction of big new air bases was being projected at that time, to build an aircraft that could operate without runways.

Surface-to-surface missiles are merely an extension of the artillery. Reconnaissance, surveillance and *direct* intervention carried out simultaneously remain the prerogatives of the piloted aircraft. It has been rightly said that new weapons never entirely supplant existing weapons. The latter can and must be developed further. The same will apply to the strike fighter, at any rate up to the time when combat becomes fully automated. But, even then, tactical aircraft will always be needed in order to detect the targets for attack.

The Soviet Union's Rockets and Tanks

A heavy self-propelled launching platform with extremely long tube, probably for the launching of a ramjet missile. (Both vehicles are moving from left to right.)

The Red Army's military parade in Moscow on the occasion of the 40th anniversary of the October Revolution on November 7th this year, leaves no doubt that the rearmament of the Soviet land forces on the basis of rocket warfare is in full swing. Although the weapons themselves caused some surprise, it is particularly noteworthy that all the models demonstrated were based on a conception of independent fighting units for a highly mobile deployment.

Basically the new rocket weapons can be considered as modernized artillery whose range, due to the employment of reaction propulsion, has been improved many times and whose mobility in the combat areas has been increased by the use of self-propelled armoured mountings serving as both a means of transport and as launching platforms. This rocket artillery offers, according to the various types, ranges from 15 up to some hundreds of miles and, when used in conjunction with shock forces such as mixed tank and infantry units, is capable of penetration deep into enemy territory. In a "conventional" (non-atomic) war the defending air forces would have some difficulty in preventing these armour-plus-rocket units building up advanced launching bases.

It is an obvious conclusion that Soviet military planners are aiming for a dual role: on the one hand widely dispersable (and mobile) ground forces for use in an atomic war, and, on the other, highly mobile ground units with a maximum concentration of fire power for conventional warfare or localized conflicts. In either case, immediately on the outbreak of war Russian rocket artillery, thanks to its high degree of mobility, could occupy forward artillery positions deep inside the opponent's territory. In any case the fact cannot be ignored that the Soviet Union has built up a fully mechanized and powerful offensive army which, if ever set in action, could only be countered by the Western powers with the use of *atomic weapons*.

*

What are the characteristics of the individual models and for which particular tasks are they intended? The accompanying photographs and comparative scale drawings of the most important rockets supplement the article published in *Interavia* No. 12, 1957, and give an overall picture of Russian military weapon developments.

Two assumptions can be made: (i) all the weapons demonstrated in Moscow appear to be capable of carrying *atomic warheads;* (ii) all the models can be considered as complete operational *weapons systems*, and are now in service with the first-line troops.

The lightest weapon, designated *Type A* herewith, is an *unguided surface-to-surface missile* powered by a solid propellant rocket motor, capable of being mounted on the 1955 model amphibious reconnaissance A.F.V. This rocket, somewhat smaller than the American *Honest John* artillery rocket weapon, is probably considerably cheaper and can be produced more simply than the latter, now in service with the U.S. Army; it is probably capable of carrying a 2,200-lb.

Self-propelled launching platform with 31-ft. long unguided surface-to-surface rocket. This weapon is mounted in a tube-like housing which can be elevated for launching.

Self-propelled launching platform with approx. 33-ft. long guided surface-to-surface weapon. The transporter is similar to that used for the unguided weapon (above), but has a cradle which can be elevated through 90° for vertical launching of the rocket.

This improved version of the 46-ton JS III A.F.V. with 12.2-cm. gun has recently entered service with the Red Army.

Guided surface-to-surface medium-range missile mounted on a twin-axle carriage and launching platform.

A new anti-aircraft tank with large turret for the mounting of twin anti-aircraft guns (calibre apparently 5.7 cm).

warhead over ranges of 15 to 25 miles. A larger and somewhat longer range (25 to 33 miles) model is the *unguided surface-to-surface weapon (Type B* herewith) with an approximately 4,400-lb. warhead. Both the *Type A* and the *Type B* require only a small handling crew which can be accommodated in the armoured self-propelled launching platform. Accompanied by anti-aircraft and ground defence A.F.V.s and fire control vehicles, these weapons systems would be capable of several days independent operation and of driving deep wedges into the enemy's forward areas, already demoralized by atomic weapon attack. Supporting these short-range missiles is the *guided surface-to-surface weapon (Type C* herewith), with greater range and relatively high accuracy, for use against the opponent's more distant defensive system. Another impressive weapon displayed was a very large *self-propelled launching platform with long cylindrical tube* approximately 60 ft. long and 24 in. in diameter (see illustration) on whose role the Russians have made no details available; the probable suggestion is that this comparatively thin-walled tube is designed for launching a ramjet missile, with ranges in the neighbourhood of 350 to 450 miles. Finally, other Red Army weapons shown in Moscow for the first time included *surface-to-surface medium-range missiles (Type D* herewith) for the attack of area targets such as air bases, lines of communication and cities.

The important question, however, is how many of these weapons of the various types are operationally available. It can be assumed that large-scale production of rockets *Type A, B* and *C* has been undertaken and that these weapons are now in service with the Red Army; these are rocket weapons of comparatively simple construction and without any of the teething troubles which still seem to beset the I.R.B.M. and I.C.B.M. As regards the status of the Russian medium-range surface-to-surface missile *(Type D)*, it has been reported that these have been in production for over a year.

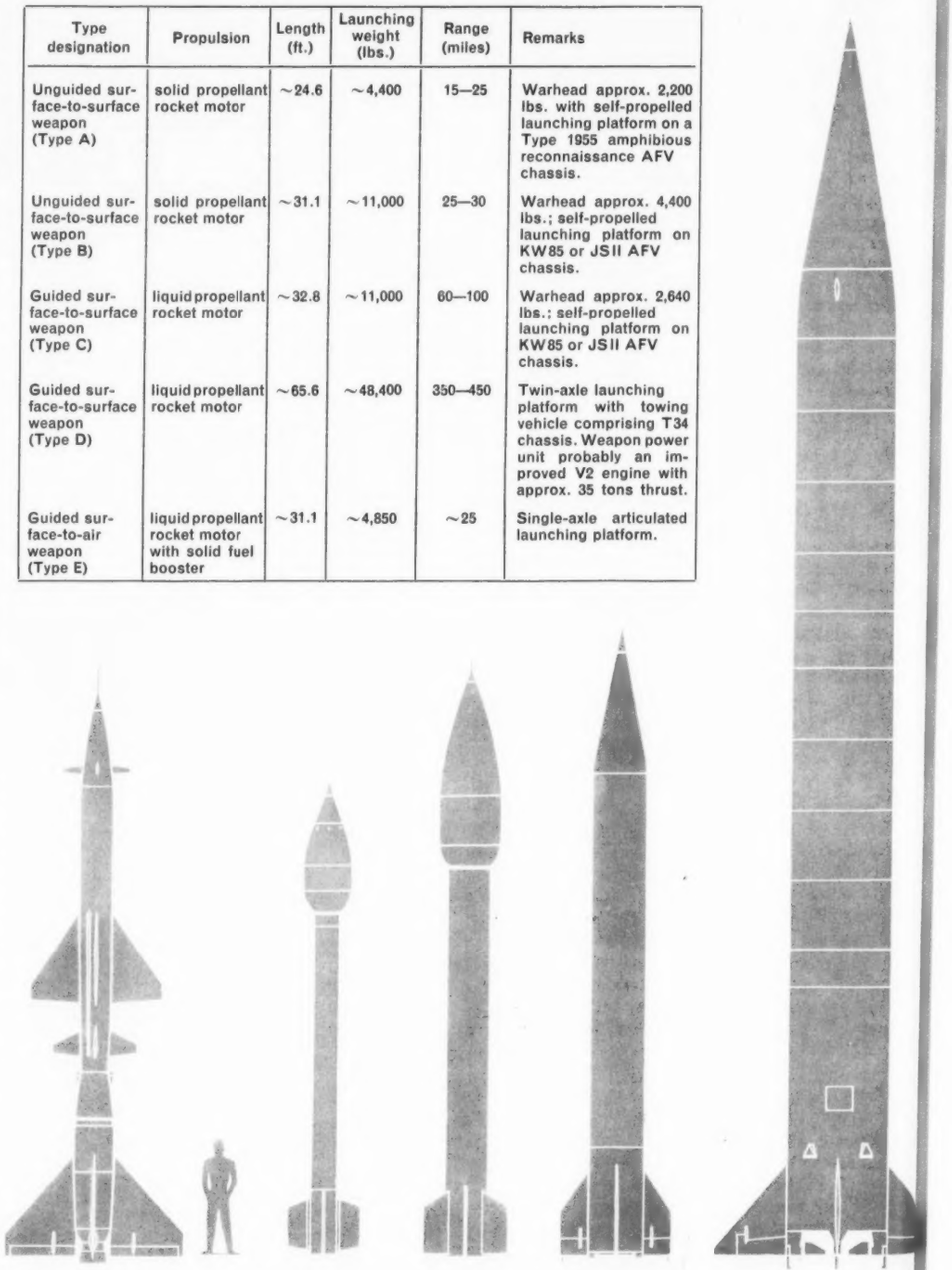
So far as the European continent is concerned then, in the unlikely event of a non-atomic war, defence against Soviet shock troops using the described armoured weapons would be the responsibility, in the first instance, of N.A.T.O.'s strike fighters, providing that these were available in sufficient quantity and with adequate armament. In the event of an atomic war, the strike fighters would also have to be employed in areas where use of tactical atomic bombs would be impossible because of the juxtaposition of friend and foe. A formidable task which will be increased by the employment of large numbers of opposing MiG-15, MiG-17 and MiG-19 fighters. It is questionable whether the *two-stage anti-aircraft rocket (Type E* herewith), which was also shown in Moscow, would be employed for the defence of forward areas. On the other hand, the appearance of the new Russian *anti-aircraft tanks*, illustrated above, leaves no doubt that the Soviet shock troops would be able to defend themselves against low-level air attack.

*

It is still too early to make a balanced assessment of the Russian weapons parade on November 7th, but one point is today very clear: this demonstration demands no less consideration than the Red Air Force display in July 1956.

U.S.S.R. Tactical Rocket Weapons

Type designation	Propulsion	Length (ft.)	Launching weight (lbs.)	Range (miles)	Remarks
Unguided surface-to-surface weapon (Type A)	solid propellant rocket motor	~24.6	~4,400	15—25	Warhead approx. 2,200 lbs. with self-propelled launching platform on a Type 1955 amphibious reconnaissance AFV chassis.
Unguided surface-to-surface weapon (Type B)	solid propellant rocket motor	~31.1	~11,000	25—30	Warhead approx. 4,400 lbs.; self-propelled launching platform on KW85 or JSII AFV chassis.
Guided surface-to-surface weapon (Type C)	liquid propellant rocket motor	~32.8	~11,000	60—100	Warhead approx. 2,640 lbs.; self-propelled launching platform on KW85 or JSII AFV chassis.
Guided surface-to-surface weapon (Type D)	liquid propellant rocket motor	~65.6	~48,400	350—450	Twin-axle launching platform with towing vehicle comprising T34 chassis. Weapon power unit probably an improved V2 engine with approx. 35 tons thrust.
Guided surface-to-air weapon (Type E)	liquid propellant rocket motor with solid fuel booster	~31.1	~4,850	~25	Single-axle articulated launching platform.



Type E Type A Type B Type C Type D

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The Aerodyne Concept

By Dr. Alexander M. Lippisch, Cedar Rapids, Iowa

Dr. Alexander M. Lippisch, who was born in Munich on November 2nd, 1894, is known throughout the world as an aerodynamicist and pioneer of the delta-wing aircraft. As Technical Director of the Rhön-Rossitten-Gesellschaft (RRG) and later its successor the Deutsche Forschungsanstalt für Segelflug (DFS), he designed the first delta-wing gliders and powered aircraft in the early thirties. Of these models the Delta 1 *Hermann Köhl* (with 36 h. p. Bristol engine) and Delta 4 *Wespe* (with 75 h. p. Pobjoy engine) became widely known. During the war he was placed in charge of a design office at Messerschmitt A.G., where he scored a great success in the design of the Me 163 "tailless" high-speed aircraft of moderate delta configuration. Operated as a short-range interceptor, this single-seater with rocket engine (thrust 3,750 lbs.) outshone all existing aircraft in performance, as it climbed to altitudes of some 35,000 ft. within two minutes and attained level speeds of more than 540 knots.

In 1943 Dr. Lippisch founded his own organization in Vienna and undertook development of further delta-wing aircraft, with much smaller aspect ratios. The chief of these was the Project P. 13, which was to have been fitted with a coal-dust ramjet. After the war he emigrated to the United States where he worked for Air Materiel Command at Wright Patterson AFB, Dayton, Ohio, and later with the Naval Air Materiel Center at Philadelphia, Pennsylvania. Since 1950 he has been head of Collins Radio Company's aerodynamic project office. Here he is responsible primarily for research work on behalf of the Office of Naval Research, aimed at the design of a high performance vertical take-off vehicle with largely automatic control and navigation equipment. Dr. Lippisch first became known in the aerodynamics field through his systematic airfoil investigation in 1918, when he was working in Professor C. Dornier's Aerodynamics Bureau. He is also known as a specialist in smoke tunnel experiments.

Editors

If we analyze the development trends of today's aircraft in order to foresee the basic design of the aircraft of the future we have to recognize two different lines of evolution.

On the one side we see that the course of the conventional airplane for military and civilian use is towards an increase in cruising speed which is made possible by better and more powerful jet engines or gas turbines. I think that most of us agree that this trend towards higher velocities in flight will prevail for many years to come. Some experts might think that for the commercial application of the airplane this speed race will stop at the high subsonic speeds since the supersonic aircraft as we see it today is less efficient than its subsonic counterpart. But this is only true for the present state of the art, and there are several indications on the horizon that new conceptions for the supersonic flow regime will break through this barrier of economy.

On the other side the helicopter has brought forward the indisputable proof that vertical take-off and landing is such a valuable asset to the characteristics of an aircraft that almost every day new concepts of aircraft configurations are coming up which are designed to fly without any forward speed but

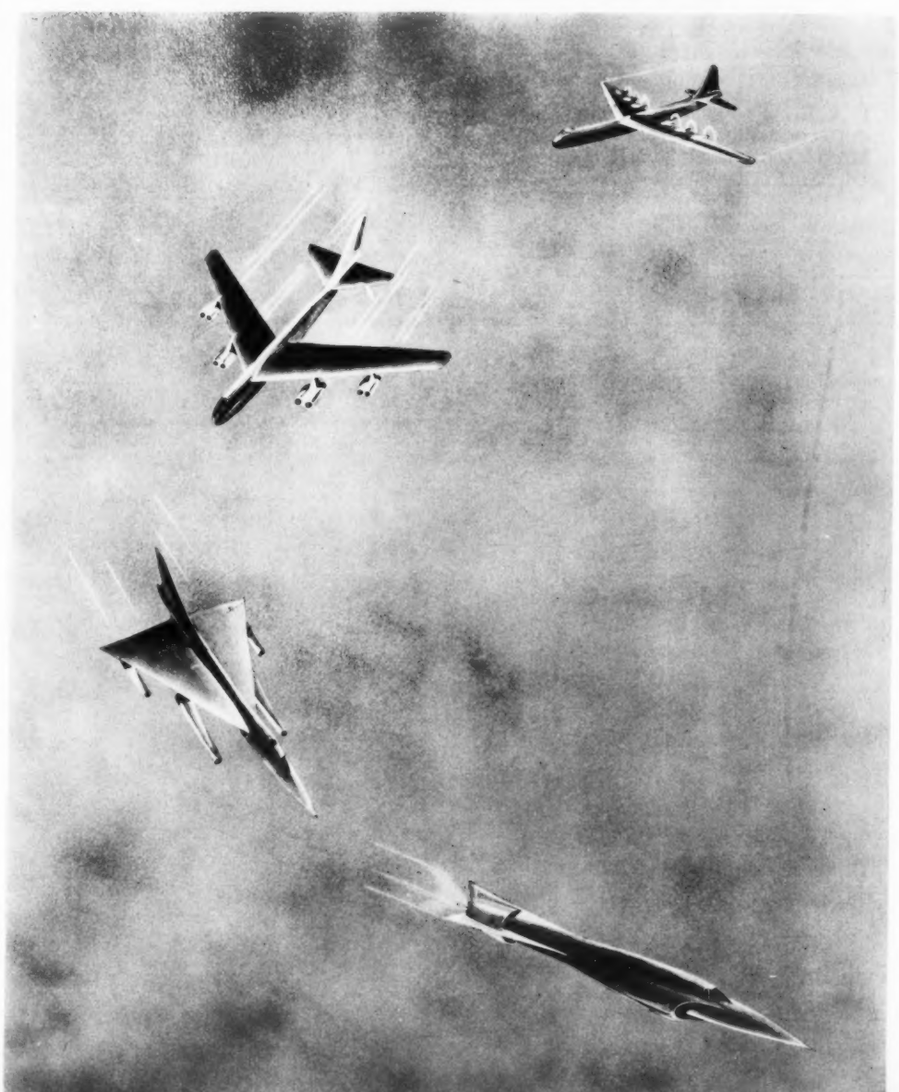


Fig. 1: The development trend of modern aircraft: from the subsonic aircraft with high aspect ratio to the wingless aerodyne.

do better with respect to range and cruising speed than the helicopter. It is not too difficult to arrive at the conclusion that the hovering flight specification should be included in the general layout of any future aircraft.

Before this technological development can take place the theoretical and experimental results for such application should be available. If we want to direct our research towards investigations needed for further progress we should first set up the general specifications for the aircraft of the future.

*

It is quite clear that the aircraft of tomorrow has to combine the characteristics of hovering flight with the high speed capacity of the modern jet aircraft. The very important question is to decide what kind of lifting device should be used for this aircraft design.

If you extrapolate the designs over the years you come to a conclusion illustrated in *Figure 1*. It shows that you will finally arrive at a wingless aircraft which will fly with an internal lift and propulsion system. We will call such a flying body an *aerodyne* to distinguish it from an *aeroplane*. But can you derive this development trend towards the aerodyne from more scientific considerations than using only common sense and an artistic view of the situation?

I think you can do that. Actually at both ends of the velocity scale a wingless design serves the purpose best. It is not very difficult to prove that wings are of no use if we fly with zero speed. The lift formula explains this and shows that lift by circulation can only be obtained if there is a translation velocity. And even if we make the circulation extremely large so that lift could be developed at low speeds, the induced drag increases so much that the power requirement becomes unreasonably large.

On the other hand, it is obvious that every bit of weight has to be saved in order to fly in a hovering attitude without too much load on the engines. Since mass flow is limited by the size of the aircraft, the weight to be lifted at zero flight speed should be as low as possible. But since you cannot save fuel load or payload the only way to obtain a more economical condition is to reduce the structural weight of the aircraft and the specific weight of the powerplant. There is a simple relation which shows this very clearly.

If W represents the gross weight, P the power available, and S the area of the cross-section through the lifting flow, the product of power loading W/P times the square root of cross-section loading W/S is constant. If we use weight in lb., power in h.p., and area in ft.^{2}, and if ϱ represents the density, and η_i the internal efficiency of the power transmission into the flow, we have:

$$\frac{W}{HP}\sqrt{\frac{W}{S}} = 53.7\sqrt{\frac{\varrho}{\varrho_o}}\,\eta_i$$

(η_i is often called the figure of merit [Gütegrad] but since it is a ratio of power it is a value of efficiency.) For practical reasons and with respect to hovering at somewhat higher altitudes than sea level we can use 40 as a constant and arrive at

$$\frac{W}{HP}\sqrt{\frac{W}{S}} = 40\ (\text{lb.}^{1/2}\ \text{ft.}^{-2}\ \text{sec.}^{1})$$

Figure 2 shows this relation in a graph. It is obvious that the weight has the highest significance. A 10% weight increase entails a 15% power increase, or a 30% increase in the cross-section of the lifting stream.

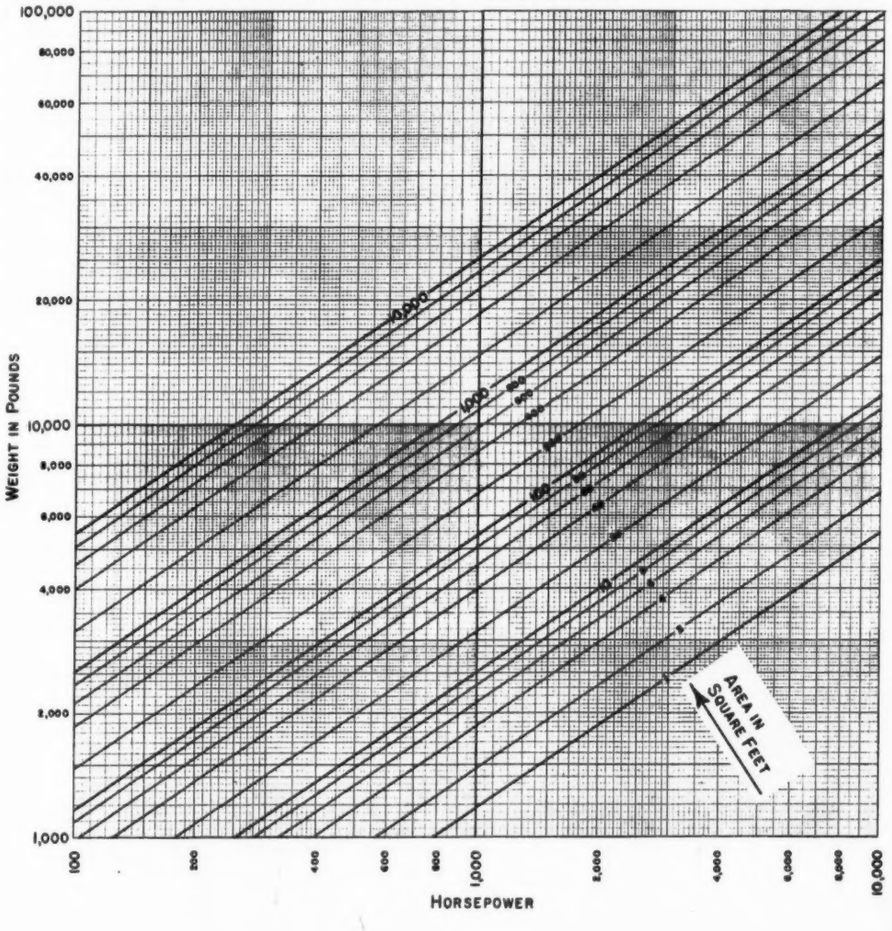
Since a reduction in weight results in a considerable reduction in the size of the aircraft (which is to a large part determined by the necessary cross-section of the lifting stream), the smaller size causes a smaller drag and results in an increase in flight economy.

The system which produces lift at zero speed can also be used for the flight condition at higher speeds. But the external flow around the body will produce additional lift. This lift due to the external flow is in large part induced by the flow which goes through the body. This can well be observed, and the entrainment caused by the exhausting stream from the internal flow improves the flow condition of the outer flow field.

This advantage of favourable conditions can be obtained only by completely eliminating wings which extend beyond the region that is under the influence of the jet stream. The external lifting flow must act on the body itself.

This is not the place to go into the explanation of such jet-induced flow, but it must be said that flow around a stream with a higher energy level differs considerably from a uniform potential flow inside and outside the body. Most of the earlier treatments of the flow around a jet stream are misleading since they assume that the pressure outside the jet is constant all over the field. Experimental investigations have proved that this statement is incorrect and have shown that an induced flow around the jet stream exists, which can only be explained by a pressure field which is

Fig. 2: Weight, horsepower and cross-sectional area for hovering flight condition.



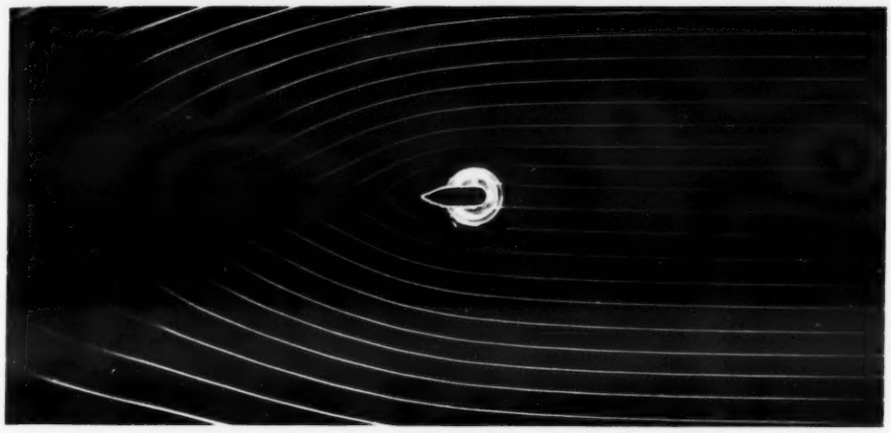


Fig. 3: Flow pattern induced by a jet stream in parallel flow. This picture was taken in a two-dimensional smoke tunnel. The jet stream comes out of a slot across the tunnel. The circle behind the model is the attachment outside the tunnel.

generated by the boundaries of the jet stream. *Figures 3 and 4* show some flow pictures of such flow fields in two-dimensional conditions.

To obtain an optimum solution for the cruising flight condition in the subsonic range the outer surface of the body has to be shaped in such a way that the outer flow induced by the jet stream causes additional lift. It is not correct to assume that such lift is generated by circulation around the body profiles. The effect we observe here is induced by a vortex sheet which forms the boundary of the jet stream. Such aircraft are therefore wingless if conditions of best over-all economy are to be obtained.

Some authors who have tried to give a comparison of different VTOL aircraft designs have expressed the opinion that a wingless aircraft, since it could not glide without power, might be compared with an airplane with extremely low L/D ratio. Actually they have overlooked the fact that such comparison is only valid if all aircraft configurations are compared in cruising flight or in any other powered flight condition. But in such case the L/D ratio should be replaced by the product of *power loading multiplied by velocity*. This much more general term derived for a winged aircraft is L/D ratio times propulsive efficiency.

A quite simple analysis on the basis of the momentum and energy concept shows that the term WV/P for a wingless configuration compares well with the values for conventional aircraft. But the economy of an aircraft considered as a means of transportation depends not on this value alone but on the product of WV/P multiplied by the payload ratio. Since the wingless configuration has a lower structural weight, the payload ratio is higher than it is for conventional aircraft.

It is well known that a ducted or shrouded body represents a more favourable configuration in the supersonic range. Busemann's supersonic biplane arrangement was the first two-dimensional example, and several further theoretical and experimental investigations have extended this concept with good results.

If we come therefore to the conclusion that the optimum layout of a future aircraft is a flying body without wings, we must at once state that such an aircraft will not be able to fly very successfully in gliding without power. Many people might object to this solution since they still have the opinion that a winged aircraft can glide safely to earth. This was once true in an earlier period of aviation. Even the conventional airliner of today is lost if all its engines stop. It can certainly glide for a while, but it cannot perform a landing away from an airport without severe damage to the aircraft and its passengers and crew. Therefore we have multi-engine powerplants so that flight can be continued in spite of partial engine failure.

The same condition of a multi-engine powerplant has to be specified for any future aircraft. An aircraft which is, on the other hand, able to land vertically is certainly safer since it does not need to fly a long time with the remaining engines at higher power settings, but can come down on any small patch of ground or hover over a ship to unload its passengers. Since the powerplant will be located within the body, the engines can be serviced during flight, especially on larger aircraft of this type.

Some configurations of vertical take-off and landing aircraft are designed to turn from the vertical take-off position to a nearly horizontal position in flight. Such procedure might be suitable for smaller aircraft designed for special military missions. But I think most people today agree that this large change in attitude is not applicable to any larger aircraft which carry passengers or cargo. In addition

Fig. 4: Two-dimensional flow pattern around a ducted body with and without propulsion. Without the internal jet stream the flow is stalling from the upper surface of the model. The jet model shown in *Figure 3* is mounted inside the duct. The jet stream pumps the air through the model and produces a flow which leaves the exit with a higher energy level.

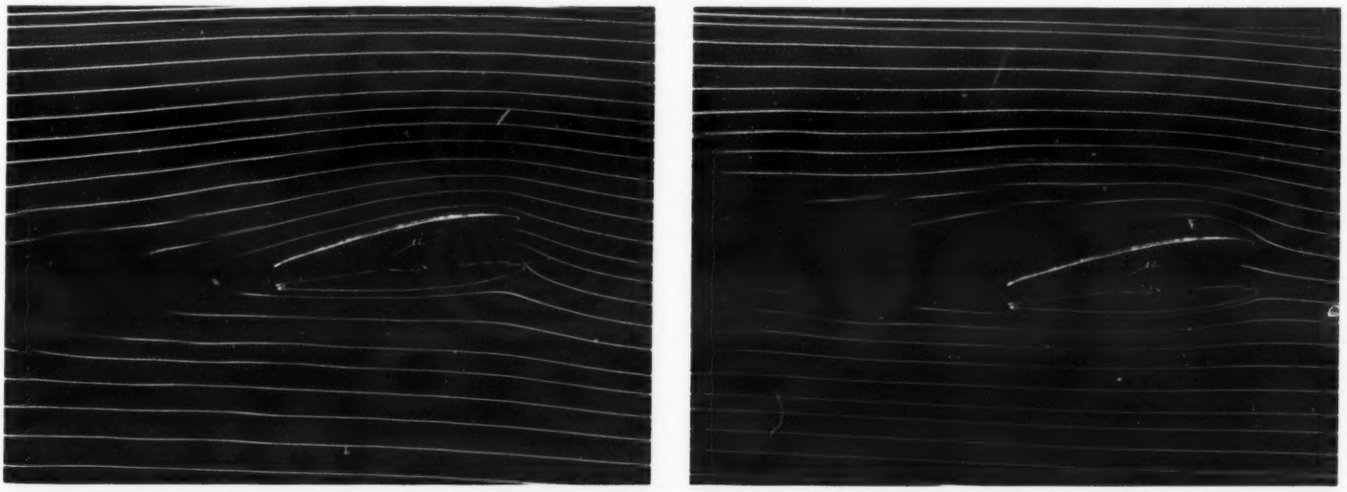


Fig. 5: The author's wingless and tailless demonstration model (model No. 2, built in 1953), which was controlled and stabilized entirely by electronic means. At the control desk, Dr. A. Lippisch.

to loading difficulties, there is difficulty in take-off and, particularly, in vertical landing if there is wind near the ground which requires a forward-inclined position of the descending aircraft.

The "tail-sitter" is not a practical solution to the vertical take-off and landing requirement. It is certainly more practical to keep the aircraft on an even keel and turn the exhausting jet stream downward to produce lift at zero speed condition. This turning of the flow might require some more power; however, if the changes in the aircraft attitude are the same as on conventional types, we do not need a full 90° turn of the flow, but only about a 60° turn which can be performed with small losses of energy.

The wide speed range which is certainly required for any future aircraft can only be obtained if the propulsive system is an internal flow system. Conventional propellers or additional helicopter rotors restrict the speed to lower subsonic values. The development of such VTOL aircraft imposes a severe limitation on speed; and, even if one might succeed in solving the initial problem within moderate speed ranges, such solutions offer no further possibilities of development. Any new concept of such aircraft should not be restricted in its high speed potential by the application of lifting and propulsive systems which cannot be applied in the higher speed ranges.

In recent times we have seen several test vehicles rising vertically into the air lifted by a tremendous power. Due to the large fuel consumption by such powerplants, the flight time is quite limited and the practical application of such demonstrations is dubious. These tests prove the excellent power-to-weight ratio of the modern gas turbine but they hardly offer any solution to the problem of the future aircraft which, besides fulfilling other requirements, should still be designed for economy of flight. One might say that this large power requirement is only needed for the short time of vertical take-off and landing, and cruising flight would require only a fraction of the power. This might be right. But, even if the powerplant could be somewhat overloaded for a short time, the weight-to-power ratio of this powerplant for the cruising flight condition is then most unfavourable, and a large part of the powerplant weight is dead weight in cruising flight.

On the other hand, we must realize that the gas turbine powerplant requires almost constant power operation and flight at higher altitudes for best economy with low fuel consumption. The power requirement for different flight conditions should make such operation possible.

If we review our present analysis and list the different points of a general specification for such future aircraft, we come to the following requirements:

1 – Take-off and landing with zero speed.

2 – Wingless configuration with an internal flow system which produces propulsion and induces lift from a combination of the internal and external flow.

3 – Multi-engine powerplant.

4 – Restriction of take-off, cruising and landing attitudes to those in use with conventional aircraft.

5 – Power requirements for take-off and cruise within limited range of variation.

There are still other points to be considered here. They concern especially the system of stabilization and control.

Our present-day aircraft are designed with control and stabilization surfaces which look as if they could be operated in the conventional way by the pilot. A closer inspection shows that this is not possible without extensive use of auxiliary mechanical and electronics equipment. This present-day system points toward a final solution where the forces applied to the aircraft are generated by aerodynamic means, while stabilization and control should be performed by the electronics system with a minimum of external surfaces (see *Figures 5 and 6*).

The final solution of the aircraft must be seen in an integrated aerodynamic and elec-

Fig. 6: A later model (1955) on a remote-controlled flight between two 80-ft. antenna masts. Power for the jet propulsion was provided by low-power electric motors, supplied with energy via a cable. The model had aerodynamic tail surfaces for control and stabilization in forward flight, as fully automatic control would involve too great a weight penalty for small models.

tronic system, the only method of achieving the highest flight economy. We must recognize that anything which causes additional drag without contributing to the generation of lift must be omitted. The flying body is not necessarily inherently stable without the electronic stabilization system. Such a system must be included in the design instead of being squeezed in as an auxiliary equipment.

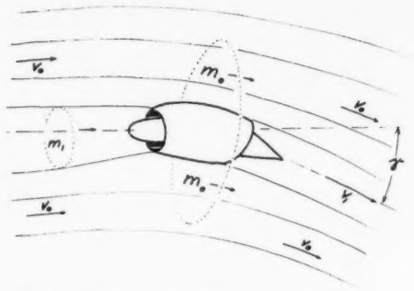
This future aircraft will no longer be derived from the natural prototype; its development will be based on scientific and technical reasoning, and it will be a man-made flying machine utilizing all the scientific and technological achievements of 50 years of development and the further progress of the near future.

*

Since we have established the general specifications of the aerodyne concept, we can begin to think about the solutions of the different problems involved in the design. At first we should try to obtain some basic conception of the performance characteristics of an aircraft which utilizes an internal flow system for lift and propulsion.

If we imagine such a body in steady horizontal flight, we can set up three basic equations for the lift, drag, and net power required. Without going into a long explanation here, we can state that the outer flow can be replaced by a certain virtual mass (m_0), which, to simplify the problem, is assumed to have the same deflection (γ) as the internal flow (m_i) behind the body. We have shown this in a sketch *(Figure 7)* and have listed these three relations which can be deduced from the momentum.

The magnitude of the outer mass depends on the shape of the body and the energy level of the inner stream behind the body. This relationship is one of the major questions to be investigated. The few tests I have made



$LIFT = (m_i v_i + m_0 v_0) \sin\gamma$

$DRAG = m_i (v_0 - v_i \cos\gamma) + m_0 v_0 (1 - \cos\gamma) + D_{parasitic}$

$POWER = \frac{m_i}{2} (v_i^2 - v_0^2)$

Fig. 7: The basic relations for lift, drag and power of a flying body with internal flow.

myself indicate that the aerodynamic characteristics of a body with internal flow running are quite different from the condition without the energized flow in the centre.

At the present time our knowledge of the aerodynamic characteristics of such configurations is very limited, and it will require some extended research to fill this gap. With some reasonable assumptions we can at least draw a performance chart of such aircraft and give the reader an example of the type of power and velocity function which we might expect. In *Figure 8* we have plotted power related to power in hovering as a function of a generalized velocity scale. The actual velocity depends on the loading of the jet stream and can vary over a wide range.

We have also plotted along the power curve the deflection angles of the flow behind the body for the different flight conditions. At zero speed this deflection angle is 90°. But in the range of the most economical flight, which would represent the condition for long-range cruising, the deflection angle is quite small and usually below 10°. This flight condition is determined by the tangent to the power curve from the origin.

We see that the power required for cruising flight is, in the case illustrated, only about 40% of the power for hovering. But it must be kept in mind that cruising flight is performed at a higher altitude; and, since power depends on altitude, and the fuel consumption of gas turbines improves considerably with altitude, the power ratio corresponds to this condition of a favourable engine operation in cruising flight.

We can divide the total power required into the portion of the power which is necessary to produce lift and the portion which is required to overcome drag. At the condition of best economy both portions are equal. At higher speeds the power to counteract drag is prevailing. At lower speeds the power required to produce lift is dominant. Since flight at higher speeds is most interesting for any further development, reducing parasitic drag is of major importance.

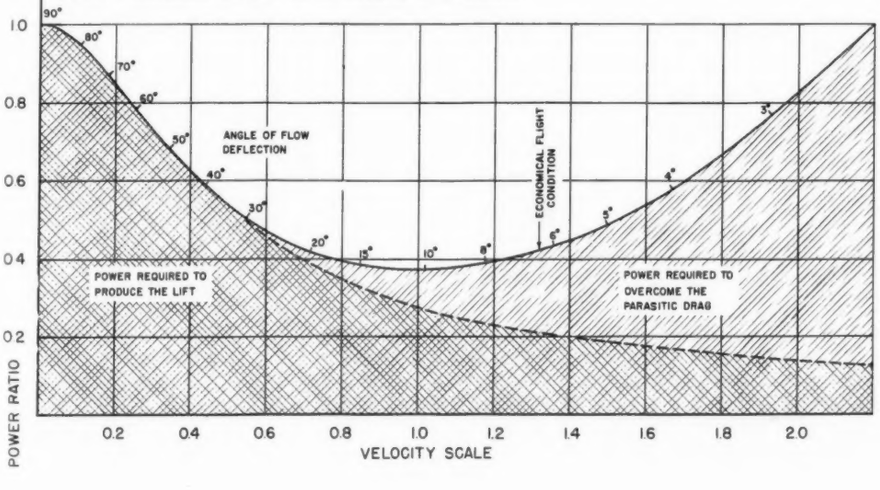
If we compare the general performance characteristic of the aerodyne concept with a similar representation for a conventional aircraft, we find that at higher speeds and in cruising flight the types of power function are similar. The difference is mainly in the low speed range, where the power function for the conventional aircraft breaks off at the stalling speed while that for the aerodyne continues to zero speed.

The fact that economical flight conditions can only be obtained with small angles of deflection of the flow behind the aircraft is very important. It shows that under such conditions the shape of the internal flow channel will give the desired deflection without the help of vanes or other additional surfaces. The internal efficiency of the inner part of the flow will reach high values, and with the stabilizing effect of this flow on the flow over the outer surfaces it is possible to obtain a flight economy which compares very well with our conventional aircraft.

On the basis of this aerodyne concept there are many different aircraft configurations possible. It is not the purpose of this article to give detailed descriptions of any of these types; it might even be misleading, since what we imagine from our present-day limited knowledge will probably not be the final solution when more information is obtained from extended research. The sketches I have given here to illustrate the article are intended to provide the reader with food for thought.

But let me say again that basic research has to be done first. And this research must be carried out in a wind tunnel and an aerodynamic laboratory through experiments which are not intended to prove an existing theory, but to supply us with new facts.

Fig. 8: Performance diagram for an aerodyne configuration.



Interview

with Hall L. Hibbard

Senior Vice President, Lockheed Aircraft Corporation

Interavia: *At the series of press conferences you have recently given in a number of European cities, you stated that Lockheed is actively studying a project for a civil supersonic aircraft which would probably have no wing, would take off and land vertically and would be capable of crossing the Atlantic non-stop at cruising speeds of around 2,000 m.p.h. Could you give us any details, such as gross weight, number and power class of engines, seating capacity, etc.?*

Hall L. Hibbard: I'm afraid I can't. On this project we are in keen competition with at least two other American aircraft manufacturers (evidently Douglas and Boeing—Ed.) and naturally do not want to put our cards on the table too soon. I should merely like to say that we are thinking of an aircraft for around 65 passengers and are working hopefully towards the goal of one aircraft that does everything, from short hops to intercontinental flights.

Interavia: *How can you solve the technical and economic problems involved in reconciling such widely varying requirements in a single aircraft?*

Hall L. Hibbard: The solution lies largely in vertical take-off. Because of its ability to take off and land vertically, a supersonic trans-Atlantic aircraft would be useful and economical even on short stages. We have given particularly close attention to the question of economy, to make sure we are not making any basic mistakes. We have found that seat-mile costs for block distances of say 200 miles are lower for this design than for today's standard four-engine airliner. It must be remembered that a VTOL aircraft wastes no time in taxying to the runway, circling the field, waiting for permission to take off or land, etc. Every minute in the air is spent on a useful purpose travelling towards the destination. Obviously, on short stages the projected all-purpose aircraft would fly at subsonic speeds, but it would still be economical.

Interavia: *However attractive the idea of a universal aircraft for all block distances may be, it is immediately obvious that take-off weights will differ very greatly for very long and very short block distances. The lion's share in the gross weight for long stages will naturally be taken by the fuel load—let us say around 100 tons for a take-off weight of 150 tons—whereas for short stages something like 25 tons would probably suffice, or a total take-off weight of only 75 tons.*

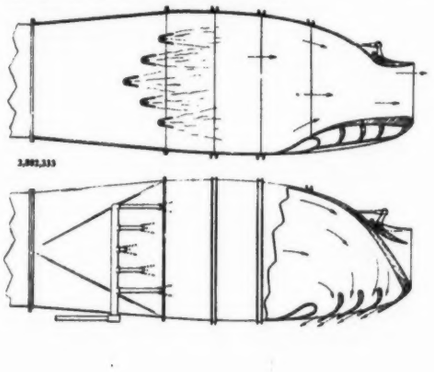
Hall L. Hibbard: In that case only half the power of the engines would be needed for take-off and landing. Incidentally, the figures you give seem to me a bit on the high side. Our investigations have shown that we should be able to achieve lower weights for engines, airframe structure and fuel consumption. The same propulsive principles can be used to build a twin-engine aircraft. Initially for military purposes and later perhaps as a kind of family aircraft. All this, of course, is assuming that piloting can be greatly simplified, compared with today's standards, by use of automatic devices.

Interavia: *What about the safety of wingless commercial transports?*

Hall L. Hibbard: Safety in large aircraft lies in the multi-engine arrangement. A four-engine aircraft with two engines out is in a much less favourable condition than, say, a twelve-engine aircraft with two dead engines. The latter will therefore be safer than conventional aircraft, particularly as take-off and landing will always be vertical, rather than tangential as at present. A twin-engine family aircraft, of course, would present different safety problems. One question which is sometimes raised is "What happens if my wife runs out of gas?". To cope with this eventuality we must perhaps provide a ribbon parachute, similar to that used in our X-7 research vehicle.

Interavia: *Do you plan to use the same group of engines both for take-off and landing and to provide forward thrust, or will you have different groups for these two tasks? Interest in the former solution, i. e., in some kind of jet deflection, seems to be indicated by the fact that Lockheed engineers N. C. Price and W. M. Hawkins Jr. have applied for a patent (USA No. 2,802,333) for a method of deflecting the discharging jet vertically downwards at the end of nozzles with a rectangular exhaust section.*

Extract from U.S. Patent No. 2,802,333:
Section through the rear of a jet propulsion nozzle with rectangular variable area exhaust (above), which can be entirely shut off for thrust reversal purposes—or take-off and landing (below). With this nozzle design, engines can be installed side by side.



Hall L. Hibbard: No comment!

Interavia: *Wouldn't aircraft with ten, twenty or more jet engines outtop anything we have yet heard in the way of noise?*

Hall L. Hibbard: Yes, I am afraid they probably will be somewhat noisier than today's big jets. But we can't say anything more definite yet. We have based our short stage economy calculations on traffic from airport to airport and have not so far seriously considered taking off or landing in city centres. True, certain city planners have suggested that giant "chimneys", inside which aircraft could take off and land, could be built in city centres, but plans of this kind seem a little too advanced at this stage.

Interavia: *How long do you envisage that development of the new aircraft will take, and when do you think it will be ready for service?*

Hall L. Hibbard: We are confident that we can build and test a first prototype within seven years, provided that we get appropriate support from the military authorities. But then it will be another seven years before the first wingless supersonic aircraft can go into airline service. In any case we mustn't expect trans-Atlantic flights before the early seventies. Besides, airlines will be well supplied with turboprop and jet aircraft up to that time and will understandably wish to amortize their equipment.

Interavia: *One last question: Won't the aircraft of the 1970 generation be unbelievably expensive?*

Hall L. Hibbard: The initial cost will certainly be substantially higher than that of today's big jets. But in spite of this, operating costs per seat-mile will be lower. At the same time traffic volume will continue to grow, and the airlines will become financially stronger. For example, who would have believed ten years ago that Swissair would be able to order three large jet transports at a unit price of more than $ 5,000,000? At any rate we at Lockheed are optimistic about the sales prospects for a supersonic trans-Atlantic aircraft which will travel faster than the sun.

VTOL Flight Test and Development

By C. E. Myers, Jr.,
Engineering Test Pilot, Convair Division, General Dynamics Corporation

Professor Theodore von Kármán has expressed the view that the tangential method of take-off and landing as developed by the Wright Brothers is out of date and should be discarded. To aid in accomplishing the "discard", let us summarize the work which thus far has been done—with particular reference to the Convair XFY-1 *Pogo Stick*—and make recommendations for future developments.

A review of significant VTOL development projects which have been active between 1954 and the present includes the following.

CONVAIR: XFY-1 *Pogo Stick*, a "tailsitter" type interceptor, is powered by an Allison YT-40A engine, which drives Curtiss electrically controlled contra-rotating propellers *(Figure 1)*. It is a single piloted delta-winged airplane with a design take-off gross weight of about 14,000 pounds. The project has been terminated.

LOCKHEED: XFV-1 is a "tailsitter" turboprop interceptor with the same powerplant as the *Pogo Stick (Figure 2)*. The main difference between this airplane and the XFY-1 is the conventional tapered wing and cruciform tail. The project has been terminated.

BELL: Bell has made two interesting attempts at VTOL development. The first vehicle *(Figure 3)* is a conglomeration of parts of other light airplanes and is powered by two J44 turbojet engines, which may be rotated from horizontal to vertical for transition from horizontal to vertical flight. Control during low speed and hovering is accomplished by compressor bleed air piped to nozzles at the wing tips and tail. Bell's most recent experiment is the X-14 *(Figure 4)*, a U.S.A.F. sponsored version of the machine described above. This airplane is powered by two Armstrong-Siddeley ASV.8 *Viper* turbojets producing 1,750 pounds of thrust each. For hovering flight, the tail-pipe diverts the jet exhaust downward to provide vertical thrust.

SNECMA: SNECMA has undertaken VTOL development with enthusiasm. Their approach to the problem displays sound planning engineering. Thus far, the product of their effort is the *Flying Atar (Figure 5)*. The test vehicle consists of an *Atar D.3* turbojet engine, surrounded by a cylindrical shell 4.8 feet in diameter. The shell contains the fuel supply, the control system and stability augmentation devices. The entire affair stands in a vertical position upon four legs which give it a height of 22.5 feet. Initially, the *Atar* was flight tested while suspended from an inverted "U" shaped structure 122 feet high. Side cables were employed as a means of immobilizing the vehicle in case control was lost. During flight within the test rig, slack is prevented from forming in the cables by electrically powered and controlled winches which sense cable tension. When tethered, the *Atar* may be flown remotely by a pilot seated at a control panel in a trailer a safe distance from the test area. Recently, it has been flown in free flight by a pilot seated atop the cylindrical body*.

* cf. *Interavia* No. 7, 1957, p. 713.

The stability and control problems, and the method of overcoming them, are typical of what will be encountered with any "tailsitter" type jet VTOL. The problems are as follows:

Roll Instability: Induced by engine torque during acceleration and deceleration of the engine. Corrected for by small jets having a line of action tangent to the cylinder body.

Gyroscopic Effects: Since the mass of the rotating members of the engine is so great in relation to the total mass of the airplane, the vehicle responds to the basic gyroscopic laws. The result is pitch with yaw and yaw with pitch. The phenomenon is countered by a black box which senses the undesired motions and directs the basic source of control, the variable position tailpipe of the engine.

The airplane for which the *Atar* engine and control system are being developed is the C-450 *(Figure 6)*, a high performance coleopter which consists of an annular wing surrounding a body of revolution fuselage.

RYAN: The X-13 *Vertijet (Figure 7)*, which made its first complete flight cycles in April of this year, is the most successful VTOL fighter configuration which has flown. Ryan engineers have overcome the typical jet VTOL stability and control problems by artificial stability augmentation devices which are still classified. The effectiveness of the artificial stability system is apparent during transition and hovering flight. Contributing heavily to the successful development and flight testing of the *Vertijet* is Chief Test Pilot "Pete" Girard. "Pete", former Chief of Aerodynamics at Ryan

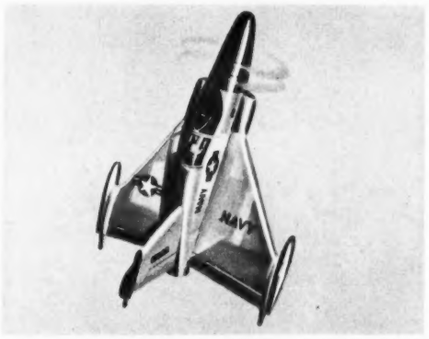


Fig. 1: Convair XFY-1 *Pogo Stick* (Allison YT 40A).

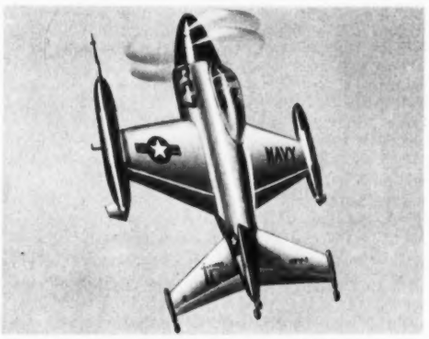


Fig. 2: Lockheed XFV-1 (Allison YT 40A).

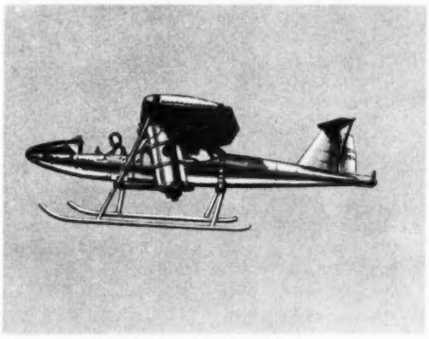


Fig. 3: Bell VTOL (two Fairchild J44s).

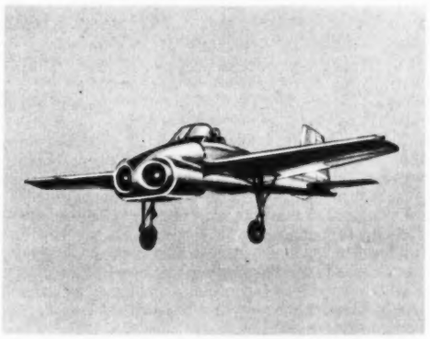


Fig. 4: Bell X-14 (two Armstrong Siddeley *Viper ASV.8s*).

Fig. 5: SNECMA *Atar Volant (Atar D.3)*.

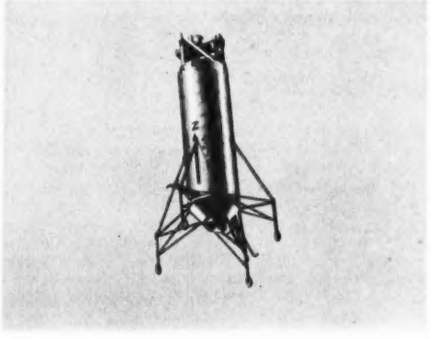
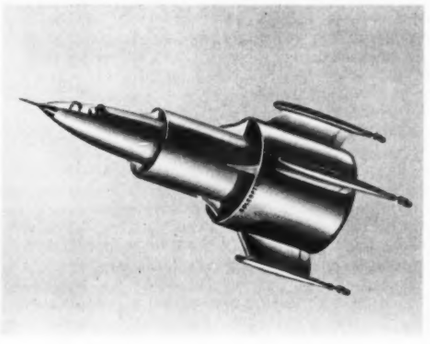


Fig. 6: SNECMA C-450 coleopter with SNECMA jet.



and a graduate of the U.S. Navy Test Pilot School, is typical of the caliber of test pilot required for successful research and development.

SHORT: S.C.1. is a delta-winged airplane with conventional tricycle landing gear *(Figure 8)*. Speculation indicates the machine will utilize four vertically mounted jets for vertical take-off and landing and one horizontally mounted jet (all Rolls-Royce RB.108s) for cruising. The control system employs some form of gyro-operated automatic stabilizer. An estimated gross weight for this airplane is 8,500 pounds. The airplane is undergoing initial flight tests in a tethered flight rig, which the British call a "gantry".

ROLLS-ROYCE: Rolls-Royce took a logical step toward VTOL development in 1954 when they began testing their "thrust-measuring rig", commonly referred to as the "flying bedstead" *(Figure 9)*. This machine is composed of two *Nene* centrifugal type turbojet engines and a minimum of structure which contains the fuel cells and the plumbing required to permit directional control of the jet exhaust. The main portion of the thrust is directed downward for lift. The "flying bedstead" weighs about 7,000 pounds. The pilot, seated unenclosed in a normal attitude atop the machine, is afforded excellent visibility in all directions. This vehicle has been successfully operated in free flight numerous times.

VERTOL: The *Vertol 76* is a tilt-wing, medium performance VTOL airplane *(Figure 10)* sponsored by the Army and the Office of Naval Research. The machine is powered by a Lycoming T53 gas turbine engine which drives two counter-rotating propellers, one in each wing. The wing and propellers may be rotated from the horizontal through 90° for vertical take-off. Take-off may also be accomplished at intermediate settings, thus affording the airplane a STOL capability. Directional and pitch control during hover is afforded by two ducted fans having their axes perpendicular to the longitudinal axis of the fuselage.

AVRO (Canada): This Company was awarded a U.S.A.F. contract for the development of a jet propelled VTOL airplane of "flying saucer" configuration *(Figure 11)*. The project is active.

HILLER: This Company was awarded a U.S.A.F. contract for the development of a twin-engine transport type of convertiplane *(Figure 12)*. It will be powered by Allison turboprop engines. The project is active.

*

In 1954, Convair and Lockheed began flight testing their respective VTOL airplanes. The intriguing aspect of these two programs was that they had no set pattern to follow. When one considers that none of the components of either airplane were proven and that a flight technique was non-existent, the magnitude of the problem is evident.

Lockheed chose to equip their airplane with a fixed landing gear so as to permit normal take-offs and landings. The major part of their test program was devoted to investigating the slow speed flight characteristics and attemping to solve powerplant problems. Many transitions from horizontal flight were performed but seldom without gaining at least a few hundred feet of altitude. A good deal of hovering was accomplished but never below a thousand feet for reasons of safety. No attempt was made to perform vertical take-offs or landings. The project was finally terminated because of engine and propeller discrepancies.

Convair chose to operate the *Pogo* strictly as a VTOL airplane from the beginning. In order to secure stability and control information in the vertical flight regime with the utmost safety, it was decided to utilize a "tethered flight" rig. Such a rig was constructed within a blimp hangar at NAS, Moffett Field. The development of a flight technique was felt to be secondary; this would be accomplished as a by-product of testing the machine. Time proved that pilot environment and the development of a flight technique were problems equal in magnitude to flight testing the aircraft.

The environment created by the blimp hangar was extremely detrimental to the progress of the

Fig. 7: Ryan X-13 *Vertijet* (Rolls-Royce *Avon*).

Fig. 8: Short SC-1 (five Rolls-Royce RB.108s).

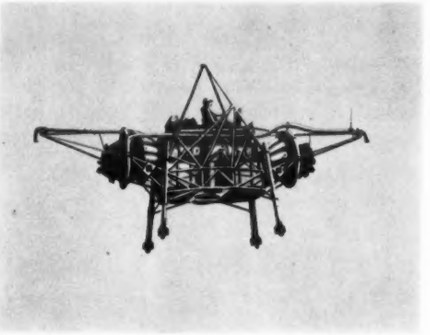


Fig. 9: Rolls-Royce *Flying Bedstead* (two Rolls-Royce *Nenes*).

flight test program. Disadvantages of the hangar-enclosed tethered operation were as follows:

1 – Turbulence.
2 – Increase in ambient temperature followed by a decrease in engine thrust.
3 – Smoke, fumes, dust and noise which contributed to pilot fatigue.
4 – Elimination of the airman's basic control reference, the *horizon*.

The pilot, J. F. "Skeets" Coleman, was faced with a basic problem: what was to serve as his control reference? The horizon was unavailable because of the enclosure within which he was operating. He chose to refer to the floor of the hangar and by some supernatural instinct, learned to hover the airplane by staring continuously back and down over his shoulder, past the trailing edge of the delta-wing, to the concrete below. He assumed this position prior to lift-off and did not dare look elsewhere until solidly back to earth. Learning to hover in this manner was not accomplished without many anxious moments on the part of both the pilot and the flight test crew. Anticipating that the pilot might sometime lose control of the airplane, the tethered rig had been designed so that during a free wheeling operation, it could be instantly locked in any position. With this in mind, the pilot, if he felt that he was losing control, could transmit the words "catch me" and immediately cut power. The tethered rig operator would lock the reel, and the airplane would swing like a pendulum until lowered to the floor.

In August 1954, the airplane was moved outside, and the first free hover flights were conducted. Further hover, and finally transition from vertical to horizontal flight, was accomplished at NAS, Brown Field, California. Coleman performed three "complete VTO cycle" test flights at Brown Field and three more at Lindbergh Field, San Diego, for a total of six.

Transitions from vertical to horizontal flight were no problem; however, the transition from horizontal flight was never accomplished without a substantial increase in altitude. Herein lies the crux of the VTOL flight problem—the pilot loses his ability to judge vertical movement when he rises more than a hundred feet or so above the terrain.

It is most disconcerting for a pilot not to know whether he is going up or down and at what rate, especially so when one considers that control deteriorates with rate of descent. This was a problem common to both Lockheed and Convair. Herman Salmon, the Lockheed pilot, used the full swiveling pitot static head, located on an extension from the left pylon, to tell whether he was going up or down; however, he had no reliable source of rate information. Up until the time of this writing, no instrument has been developed which will provide reliable rate of descent information while subjected to the vertical flight environment of the XFY-1.

During free flight, ground personnel provided the pilot of the *Pogo* with an indirect aid by observing the airplane's vertical motion through a grid, judging the rate of descent and relaying the information via radio. Direct communication also served to provide the pilot with geographical orientation after a transition to vertical flight. Although within the boundaries of the field, the pilot easily became disoriented, since his only view of the world was a "small piece of pie" which he observed by staring earthward between the left side of the fuselage and the left wing (remember, his flight control reference was the ground due to the tethered training in the hangar). This same technique of looking down and back magnified the environment problem, in that it exposed the pilot to the tremendous blast from the contra-rotating propellers; this led to the development and use of a bothersome full face coverage helmet, which, in the end, increased the pilot's problem.

Early in 1955. a most important episode took place. Many people were not convinced of the requirement for "tethered flight training" to prepare a pilot for VTOL operations. Johnny Knebel, then a Convair production pilot with a wealth of varied airplane experience, volunteered to attempt to fly the *Pogo* in hovering flight without the benefit of "tethered training". He was thoroughly briefed by Coleman and obtained the "feel" of power control by driving a vertical engine test stand which was free to move up and down a distance of six feet. Johnny actually became airborne at Lindbergh Field, performed a few partially controlled gyrations, and landed safely with only minor damage to the airplane.

This phase of the test program ended abruptly. The consensus of the pilot and those who had observed the flight was that tethered flight training is a necessity. With this, I am in complete agreement. A pilot who is learning a new flight technique must be given an opportunity to make errors without damaging the test vehicle. The airplane, especially one which employs an automatic control stabilization system, must be initially tested under conditions such that it may malfunction without destroying itself. To embark on a VTOL test program without taking advantage of a tethered test rig is a bold gamble not consistent with the engineering necessary to fully develop such a flying machine.

A decision was made by the Bureau of Aeronautics to build a tethered flight rig at NAS, Brown Field, so as to facilitate training of more pilots, both Convair and Navy. The object of this program was to obtain additional pilot input and develop a group of men who would serve as a nucleus for further VTOL development. In addition, the new Convair pilots were to fully investigate the slow speed flight regime of the *Pogo* and develop a flight technique for performing a constant altitude transition from horizontal to vertical flight.

It was at this point, in April 1956, that I assumed the position of XFY-1 project pilot. Prior to beginning tethered rig training, I was introduced to the

powerplant and the *Pogo* environment problems through the medium of the movable vertical engine test stand. I began training in the engine stand by utilizing the technique of locking down and back to judge vertical motion. Intuition told me this method was not the best; in addition, I felt physically incapable of coping with the machine if this technique was necessary.

The Navy provided me with eight hours of helicopter training for the purpose of familiarizing me with vertical flight problems. During the helicopter training, I proved to my own satisfaction that I could not hover by staring at the ground directly below. Attitude control during flight is accomplished by reference of airframe movement relative to the horizon and the surrounding terrain. This is true of all airplanes, including the tailsitter types. The validity of this basic technique was corroborated by both Herman Salmon of Lockheed, and "Pete" Girard of Ryan.

In an attempt to detect vertical motion, I relied on the same "crutch" which was used by Navy pilots in performing carrier approaches before the days of the mirror landing system. It is a fact that when one is at the same level with distant objects, they appear to coincide with the horizon. Should a pilot desire to approach a runway or a ship at a constant altitude of 100 feet above the surface, he merely flies his airplane so that some distant object 100 feet in height appears to remain even with the horizon. As he varies his altitude, the object, such as a control tower or the stack of a ship, will appear to move above or below the horizon. This motion provides the pilot with rate information.

The validity of this method for VFR operation was borne out by my helicopter training and the success of the tethered flight operations. The method has an important limitation: it is practical at low altitude only (below 150 feet), hence the importance of performing a low level, constant altitude transition. Using the described flight technique, Knebel and I were able to accomplish our training in six weeks instead of the originally estimated six months.

Coleman had reported that free flight hover was less difficult than tethered flight. The truth of this statement is obvious when one considers the effects of the tethered rig on the controllability of the airplane and the restrictions which tethered operation places on the pilot. In tethered flight, the nose cable is continually pulling upward and toward the center of the rig. This is a force which the pilot must allow for during any excursion toward the perimeter of the flight area. This force effectively cancels a portion of the control available to the pilot. The effect becomes more pronounced as the airplane climbs higher in the rig. If loss of control was experienced during free flight, the pilot could easily recover by applying full power. When operating in the tethered rig, especially near the top, application of full power must be avoided—the only solution for loss of control is to cut power and rely on the rig operator to lock the reel. Rig flying is an operation calling for strict obedience to pre-determined procedures and faith in the equipment and supporting personnel.

Evaluation of the aerodynamic and stability qualities of an airplane during tethered flight is complicated, since one must mentally eliminate the rig effects which are associated with any motion or reaction. Maximum advantage from a tethered flight rig is gained during:

1 – Pilot Training
2 – Engine Development
3 – Automatic Control Development
4 – Pilot Environmental Improvement
5 – Systems Check-out.

The success of the project was short lived—the pilots reached the point where they were ready for free flight, but engine and propeller unreliability remained as an ominous spectre. An engine failure in a VTOL airplane during a transition must be likened to a wing failure of a conventional airplane during an approach to a landing. The obvious high risk was impetus for Bureau of Aeronautics Representative, San Diego, with Convair's blessing, to recommend termination of the program. The *Pogo Stick* was removed from Brown Field in November 1956, and ordered to the Smithsonian Institute in September, 1957.

*

One cannot speak of possible engine or airframe failure without simultaneously considering pilot escape. Very low altitude escape capability is an essential for VTOL operations—both the Lockheed and the Convair airplanes provided this necessary potential. The XFY-1 system relied on a series of static lines linked between airplane, ejection seat and parachute. The sequence was as follows:

1 – Seat handle was raised, trigger pulled.
2 – Seat ejected.
3 – Line between airplane and lap-belt opened the belt after two feet of movement.
4 – Line from airplane to ejection seat snubbed the seat after eight feet of travel, thereby separating the pilot.
5 – Line between the seat and the parachute pin released the chute after a three foot separation between seat and pilot.

This escape system was proof tested, and we felt confident that we could escape at one hundred feet above the terrain.

In regard to VTOL developments which are now in progress, I feel strongly that flight operations should not begin until a satisfactory escape system is proven for each type of airplane. Imagine the result of a sudden single powerplant failure in the case of a twin-engine convertiplane. The pilot and co-pilot must have an immediate means of escaping from the tumbling, falling fuselage.

One of the unsolved problems, which was especially bothersome during free flight operations, was the lack of a means of determining the true static thrust of the powerplant. The maximum gross weight prior to any particular flight was based on a required thrust-to-weight ratio of 1.15 to 1. During the *Pogo* test flights, the thrust was calculated using standard formulae; this is hardly an accurate method. It could result in an unsafe operation or, what is more likely, conducting flight tests at weights below those permissible. With instrumentation being at a premium and weight being critical, the value of knowing the thrust is obvious.

As the project ended, progress was being made in the development of a hydraulic direct reading airplane thrust scale. Another system which was proposed involved suspending the airplane, plus large weights, from the tethered flight rig with a Baldwin load cell inserted as an integral part of the suspension. The difference between the strain gage weight readings at zero power and full power should have given the thrust of the engine.

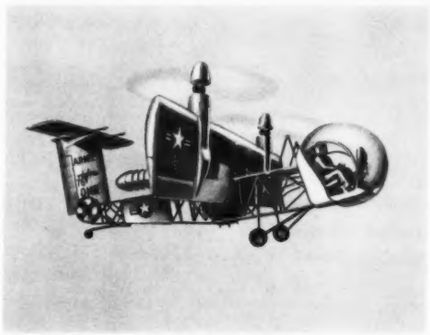


Fig. 10: Vertol 76 (Lycoming T53).

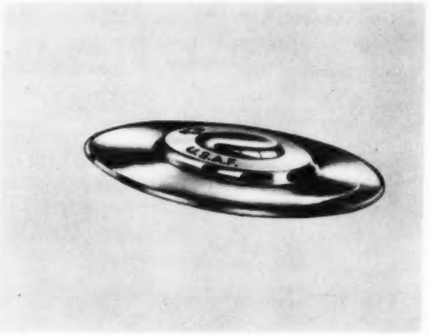
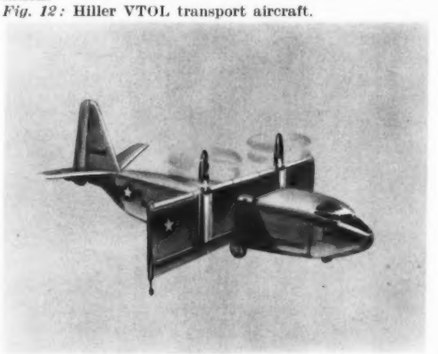


Fig. 11: Avro VTOL project of "flying saucer" configuration.

Fig. 12: Hiller VTOL transport aircraft.



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At the present state of the art, we are a long way from producing a reliable, practical VTOL fighter or high performance transport. Specifications for future designs should include:

1 – Good visibility from the cockpit.
2 – Manual control system sufficient to effect a landing.
3 – Automatic control system for vertical flight which will normally be utilized for landing.
4 – Autopilot which can be coupled to a ground control system for bad weather and night landing and take-off operations.
5 – Flight instruments for vertical operations, primarily a good rate of descent instrument.
6 – Low altitude pilot escape system.
7 – Thrust measuring equipment for both test vehicles and operational airplanes.
8 – Tethered flight rig for pilot training and engine and instrument development.
9 – Reliable powerplant.
10 – Ground operating areas which are designed to dispose of the hot exhaust gases from the engine.
11 – Fuselage, wing, and tail configuration should permit a safe belly landing in case of a power failure at altitude.

Insofar as future development and flight testing are concerned, I suggest that organizations who are awarded development contracts make a concerted effort to review all that has been accomplished during the past three years—such a review of past efforts will be profitable. Complete reports on the projects conducted by Lockheed, Ryan and Convair and others are on file with the Departments of the Navy and Air Force. Comprehensive reviews of the work accomplished by Short and SNECMA are available through direct contact. In addition, there are many men available for personal consultation. To stumble forth and repeat the errors of the past is inexcusable.

Through first hand observation, I have concluded that VTOL development is an extremely interesting but equally expensive task. Interesting, because few have worked in this area; expensive, because it is not possible to utilize proven standard airplane components; instead, the various main components must be especially designed and developed for this relatively strange environment. In addition, the main components, such as engine and control system devices, must be more reliable than for either the airplane or the helicopter. The accomplishments thus far have not been in proportion to the total expenditure, primarily because of the sporadic distribution of funds and development efforts.

At this point, based on consideration of

1 – Desirability of VTOL
2 – Practicability of VTOL Operations
3 – Total Developmental Task
4 – Requirements for Defense,

the Department of Defense should make a decision as to whether or not industry is to continue an effort toward producing a VTOL fighter airplane. In making this decision, it should be kept in mind that a "half-hearted effort" will fail.

A VTOL weapon system can be successfully produced only if supported by almost unlimited funds and a maximum effort of a qualified portion of the aircraft industry.

V.T.O. or S.T.O.L.?

By Derek Wood, Interavia's London Editor

During the past six months plans for supersonic airliners for the 1970s have been getting firmer on both sides of the Atlantic, but the tremendous problems of layout, reasonable landing and take-off performance, economy and noise still seem very far from a solution.

In Britain, the "Consortium" of seven firms, plus the two Corporations and the Royal Aircraft Establishment, have put a full research programme in hand and are undertaking wind tunnel tests—although it may well be a year or two before industry can get down to building a prototype.

One of the main themes for discussion has been whether to go for V.T.O. or S.T.O.L., and the arguments have been strengthened on both sides by the announcement of *Dr. Griffith's* project for a North Atlantic airliner with 12 forward and 56 downward firing turbojets.

It is claimed that V.T.O. will reduce structure weight to a minimum, ease supersonic problems, and do away completely with long runway requirements. In addition, what wing there is can be designed purely for the cruise case.

A general concensus of opinion round the industry, however, is that S.T.O.L. is the more likely for a supersonic transport.

There has been some confusion in the press because B.E.A. requires a V.T.O. for the late 1960s. The B.E.A. requirement is, however, for a *city centre—city centre* vehicle which will not be supersonic. At present the Corporation can see no solution to the noise problem on a straight V.T.O. and is therefore likely to concentrate on rotary wing types.

V.T.O. itself seems likely to have much greater application in the military sphere and it may well solve a number of combat aircraft problems in the next two generations. The military designer can accept noise etc. with much less trepidation than his civil counterpart. The trials of the *Short SC-1* with four downward firing and one horizontal RB-108 turbojets will therefore be watched with very great interest.

For the civil airliner, there are certain fundamental difficulties for which answers are so far lacking. First and foremost is noise; the effect of 56 downward firing engines all at full thrust would be indescribable and would leave the threshold of pain far behind. In addition, very little is known about *noise fatigue* which is already occupying Boeing and Douglas engineers with their 17,000 lb.-thrust jet effluxes next to flaps and ailerons.

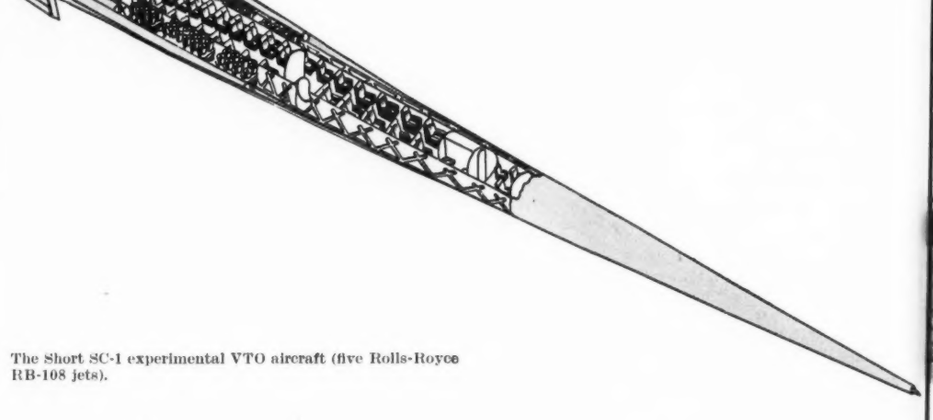
Noise fatigue has also been found serious in British rocket engine testbeds, where long cracks have appeared and rivets broken around the rocket nozzle. Experiments so far show that jet exhaust noise in the high thrust levels greatly reduces the life of bearings, rods, screws and other parts, and this is over and above normal fatigue levels.

The next thorny issue concerns pure *economics*. It is admitted by most of the designers in the U.K. working on supersonic projects, that such machines will be at least 50 percent more expensive to operate than subsonic jets (cf. *Interavia* No. 4, 1957, page 318). A rough estimate gives engine maintenance as about 25 percent of total operating costs on present four-engined jets (excluding fuel and oil). If, therefore, the number of engines is increased to 12, 24, or even more than 60, the rise in operating costs through engine maintenance is likely to be astronomical, however "simple" the engines are.

Certain other fundamental snags also become apparent. For instance, if a V.T.O. was used on the North Atlantic route, its vertical battery could consist of engines which would only be used for very short periods four times on a return trip London—New York. Put the same machine on a medium or short run, where it does eight, ten or even more landings and take-offs in the same period—assuming high utilization is the only way to get economy —then the V.T.O. battery will have to be of longer life, and will require more attention.

Finally, the all-up weight of any V.T.O. supersonic transport will have to be projected with an exceptional degree of accuracy, otherwise more V.T.O. power will be needed and as one designer put it, "someone had better leave some spare holes for extra engines!"

The *S.T.O.L. solution* is the most in favour in the U.K., and here the deflected jet or the V.T.O. battery would be a solution, for a moderate downward component plus normal horizontal engines would give very reasonable runway lengths and would avoid most of the pure V.T.O.'s problems where the whole weight of the aircraft hangs on downward thrust. Several S.T.O.L. plans have been produced in the United Kingdom, including blown flaps of various types, "cold" and "hot" jet flaps, tail-first layouts with blowing on both tailplane and wings, jet deflection, and vertical ducted fans buried in the wings.



Project for a VTO commercial transport aircraft of extreme delta form to attain cruising speeds of Mach 2.6. It is fitted with 56 downward firing jet engines (in rear part of the stub wing) and 12 forward firing jets (in the fin unit). The passengers will sit in a windowless tube flanked on both sides by fuel tanks. (According to Dr. Griffith.)

The Short SC-1 experimental VTO aircraft (five Rolls-Royce RB-108 jets).

Tupolev Tu-114 Rossiya

A turboprop transport for 170/220 passengers

With the public demonstration of an almost 150-ton turboprop aircraft for 170/220 passengers Aeroflot unveiled an aircraft category which is not yet available to Western airlines: the extra-heavy turboprop transport for very long distances.

Fitted with four NK-12N propeller turbines by Soviet engine designer Kuznetsov, the Tupolev Tu-114 *Rossiya* is a low-wing model with moderately swept wing (mean angle of sweep roughly 30°) and long fuselage as in the Tu-104 and Tu-110. Wing shape, engine arrangement and undercarriage show unmistakable resemblances to the Tupolev turboprop bomber (N.A.T.O. designation *Bear*).

The main cabin is divided into several compartments. In the standard layout these are as follows: 41-seat lounge, restaurant for 48 persons, 54-seat passenger cabin, four smaller cabins for a total of 24 passengers or three sleeper compartments with 12 beds, two galleys, various coatrooms, hand baggage compartments, toilets, etc. One of the compartments will be reserved for passengers travelling with children.

The standard version thus has accommodation for roughly 170 passengers. A tourist layout for shorter stages will be able to carry up to 220 persons, while a luxury version for long distances has a capacity for 120 passengers. The crew of ten comprises two pilots, a navigator, an engineer, a radio operator, three stewardesses and two cooks.

No official details of the Tu-114's performance have so far been released. It is reported, however, that cruising speed at the upper edge of the troposphere is 430 to 480 knots, which would indicate that the propeller blade tips reach supersonic Mach numbers. As, however, the engines are relatively far from the fuselage, the noise of the large, four-blade contra-rotating propellers should not be too noticeable inside the cabin. It may also be assumed that the cruising rating of the civil propeller turbines has been slightly reduced compared with the military version (in the *Bear*).

The gross weight of roughly 135 tons would suggest a range of at least 4,300 nautical miles, so that the *Rossiya* could operate non-stop between any of the world's major air traffic centres. If the Soviet engineers succeed in developing its super-powerful Kuznetsov turbines to a high degree of operational reliability—which is likely in view of the military experience with this engine type—the Soviet Union would be in a position to offer an efficient long-range aircraft as a rival to American and British models for international air transport.

Chief Pilot A. Yakimov at the controls of the Tu-114.

The forward lounge for 41 passengers.

This front view of the Tu-114 shows the distance between the turboprops and the fuselage side.

Restaurant with seats three abreast.

Italian Air Transport Under a New Flag

ALITALIA

BY INTERAVIA'S ROME CORRESPONDENT

Scheduled air transport in Italy has experienced, at a twenty years interval, two epochs which, despite differences in political and economic conditions between the pre-war and the post-war periods and despite technical advances, resemble one another fairly closely as regards organization and development.

The first air services were inaugurated in 1926. Società Italiana Servizi Aerei, of Trieste, the first company to enter the air transport industry, was joined by other airlines, such as Aero Espresso Italiano, of Brindisi, Società Anonima Navigazione Aerea, of Genoa, Avio Linee Italiane, of Turin, and Società Aerea Mediterranea, of Rome, all of which, with the exception of Avio Linee Italiane which attached itself to Fiat, later united to form the flag airline Ala Littoria. The latter's emergence coincided with the peak period of Italian civil aviation. The only route not included in the unified network was the South Atlantic route, which was operated by the newly formed Linee Aeree Transcontinentali Italiane. During the war (which for Italy began on June 10th, 1940) airline fleets and personnel were mobilized to form the Comando Trasporti Aerei Speciali, leaving only limited means for civil transport.

After Italy's capitulation on September 18th, 1943, Ala Littoria, Linee Aeree Transcontinentali Italiane and Avio Linee Italiane were still in existence in the form of organized nuclei, but most of their flying equipment was in military hands. The Armistice conditions forbade commercial air transport and left the Government (which had taken refuge in southern Italy and did not return to Rome until June 4th, 1944) merely the right to operate "military courier" services to meet the communications requirements of Government agencies and, later, of private individuals.

In 1946, twenty years after its birth, the air transport industry made its reappearance as a result of the bilateral agreements signed by the Italian Government with Trans World Airlines on the one hand, and with British Overseas Airways Corporation on the other. These agreements led to the formation of Linee Aeree Italiane and Alitalia, Aerolinee Italiane Internazionali respectively. Capital was provided by the Italian State and the two foreign airlines, each contributing 40 percent to the company concerned, with the remaining 20 percent being offered to Italian private investors. Very soon other companies, founded by private enterprise, came into being; their sole object was to make money by buying and selling surplus U.S. Air Force flying equipment. As all these latter companies were found to operate in the red, it was decided to merge them around their financially strongest member, Avio Linee Italiane, which had been reformed by Fiat. The new, unified airline operated under the name Ali, Flotte Riunite. However, the merger was not sufficient to ensure a promising future for the post-war private airlines. The two companies which enjoyed American or British support managed to hold their own, though they, too, had their ups and downs. Ali, Flotte Riunite was placed under liquidation and transferred its aircraft, installations and operating licences to Linee Aeree Italiane.

As political conditions developed, Italian participation in the two companies became stronger, through the reduction of the foreign share in each to 30 percent on the one hand, or through amendments to the companies' internal articles of association.

This development left Linee Aeree Italiane and Alitalia, Aerolinee Italiane Internazionali as the only operators of Italian-flag scheduled air services and to meet, separately but in a spirit of friendly rivalry, foreign competition. The latter has been particularly keen because of the trend towards liberalization of traffic which has been apparent in most quarters, and because of Italy's geographical situation, at the crossroads of the most heavily travelled international routes. In these conditions the suggestion was put forward that a similar kind of merger be made as helped forward the development of Italian air transport in the Ala Littoria days. But the composition of the two companies' capital did not lend itself to a majority decision. In the case of Alitalia, the majority of the shares were by now controlled by the State, through the Istituto per la Ricostruzione Industriale. In that of Linee Aeree Italiane, the majority was held jointly by T.W.A. and Italian private investors. The Istituto per la Ricostruzione Industriale then obtained a majority holding during 1957 by acquiring a block of shares from one of the private investors. Once this transaction had taken place, a merger became possible. Since it was considered desirable to retain a compact management structure and to avoid burdening the unified airline with the financial liabilities of either of the two companies, it was decided that Linee Aeree Italiane should go into voluntary liquidation, and that its personnel, installations and services should be taken over by Alitalia. As a result, the latter has replaced its secondary name, Aerolinee Italiane Internazionali, by Linee Aeree Italiane.

Count Nicolo Carandini (left; President of Alitalia) and Bruno Velani (Managing Director, Alitalia).

New Alitalia office building in Viale Pilsudski, Rome.

Alitalia's capital, formerly of 4,500,000,000 lire, has been raised to 10,000,000,000 lire by the issue of new 10,000-lire shares to existing shareholders, at the rate of 11 new shares for every 9 held. Any shares not taken up by old shareholders may be distributed by the Board of Directors. T.W.A. has taken advantage of its right to withdraw its share in the capital of L.A.I., but B.O.A.C. and B.E.A. have decided to leave their money in the new company, whose capital is now distributed as follows: 71.5 percent held by the Italian State, 15 percent by private investors (the biggest of whom is Fiat) and 13.5 percent between the two British corporations.

Count Nicolo Carandini, former Italian Ambassador to the United Kingdom, remains as Chairman of the company, and Engineer Bruno Velani, who has administered the airline since its formation, has been confirmed in his position of Managing Director. General Aldo Urbani, hitherto Chairman of L.A.I., has been appointed joint Vice-Chairman with Lord Douglas of Kirtleside. The Board comprises 15 members, including the Chairman and two Vice-Chairmen; nine of the members already belonged to Alitalia, four came from L.A.I., and two have been nominated by the Ministry of State Holdings, which exercises governmental control over I.R.I.

The unified company has kept on all the personnel employed by the two airlines before the merger, retaining the old gradings, seniorities and rates of pay. The staff now consists of 25 managers, 836 administrative employees, 1,572 technicians and 559 aircrew, including 279 pilots.

The fleet, including aircraft on order, totals 45 aircraft: six DC-7Cs, eleven DC-6s and DC-6Bs, ten *Viscounts,* six Convair 440s and twelve DC-3s.

The actual merger came into effect at midnight on October 31st, 1957. On this date the network of the unified company covered 50,200 miles, 43 services were operated, and an average of 1,560 hours 38 minutes were flown per week. The major non-Italian cities included in this network were New York, London, Frankfurt, Vienna, Teheran, Johannesburg, Tripoli, Tunis, Buenos Aires and Caracas, to which must be added points of call in 29 countries. Sixteen Italian cities have daily services in both directions, the greatest volume of traffic being recorded between Milan and Rome.

The company's offices are housed in an eight-storey building in Viale Pilsudski, Rome, with operational and technical services at the airports.

Reservations are to be handled centrally by a very close teleprinter network, which will probably be operated by a subsidiary of Alitalia.

Plans for the future are divided into a number of stages. For the first stage, two main targets have been set, based on the aim of maximum productivity. The first aims at improving the quality and frequency of the services connecting Italy to the United States, by allocating DC-7Cs to the direct intercontinental services and increasing the number of flights operated by DC-6Bs. The second target is to modernize the domestic network, by placing *Viscounts* and *Metropolitans* in service wherever possible. Only those few cities which still do not have runways long enough to cope with these aircraft will be excluded from the modernization programme.

Improvements will also be made in the major international services which cross Italy longitudinally (such as Tripoli—Catania—Rome—Milan—London) and the intercontinental services which pass through Italy in the transverse direction (such as Beirut—Athens—Rome—Lisbon—Isla do Sal—Rio de Janeiro—Sao Paulo—Montevideo—Buenos Aires).

Later plans call for the successive opening of services to Canada, Japan and Australia, with extensions to Asia and Africa.

Like all the airlines which plan to develop their intercontinental operations, Alitalia must order jet aircraft.

In the investment programme which it has prepared for the next four years, the Istituto per la Ricostruzione Industriale has included the funds required to modernize Alitalia's fleet; these funds will probably be obtained by increasing the share capital and by the provision of credit, so as to spare the company excessive financial burdens. Today Alitalia takes seventh place among European airlines. Though it has resolutely excluded from its plans for the future any project aimed solely at prestige, it is determined that its prestige shall be established on economic stability, the quality of the service offered and technical excellence, in an atmosphere of effective international collaboration.

Lord Douglas of Kirtleside (B.E.A.; left) and General Aldo Urbani (L.A.I.) have been elected Vice Presidents of the newly formed Alitalia.

Alitalia Board of Directors

Gen. Umberto Baistrocchi.

David Craig.

Dr. Mario Guidi.

Giovanni Pedace.

Danilo Sartogo.

Dr. Ercole Agosta.

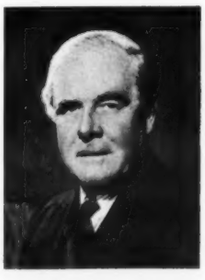
Dr. Giuseppe Zuccoli.

Antonio Sorrentino.

Luigi Acampora.

Dr. Tullio Torchiani.

Dr. Enrico d'Arienzo.



Lord Francis James Renell of Rodd.

Jet Age International Airport

New York International Airport's new Arrivals Building and Airlines Wings.

The ceremonial opening of the new International Arrival and Airline Wings buildings at Idlewild on December 5th marked the completion of the first stage in the development of a huge modern Terminal City within New York's International Airport.

The new buildings, together with the control tower, are the dominant features in the Port of New York Authority's $ 150,000,000 plan to meet the requirements of the jet age and to make Idlewild the aerial gateway to the United States. Completed in just over two years at an approximate cost of $ 30,000,000 the three storey buildings are 640 ft. in depth with an overall length of 2,300 ft. The arrival building itself covers an area of 362,000 square feet and houses all the health, immigration and customs services together with a restaurant, cocktail lounge, waiting rooms and shops; the two wing buildings house the offices, ticket counters and lobbies of the fourteen foreign flag airlines using Idlewild. Four double-deck arcades provide enclosed passage from and to twenty-four aircraft positions.

Foreign airlines will use the new buildings for both departures and arrivals, while the United States airlines will use them only for international arrivals. Incoming passengers will disembark, clear health and immigration, claim their baggage, clear customs and reach their ground transportation all on the lower level. Visitors meeting incoming passengers can view the entire customs procedure from two 500 ft.-long glass enclosed observation galleries on the floor above.

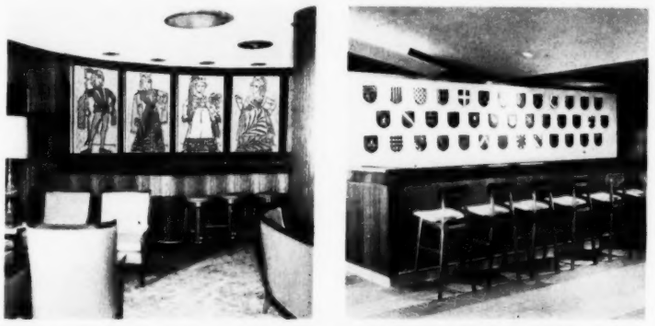
Outgoing passengers by foreign carriers are processed by the individual airlines in the wing buildings where the following companies have facilities:

East Wing:	*West Wing*
B.O.A.C.	Aerolineas Argentinas
KLM-Royal Dutch Airlines	Air France
Linea Aeropostal Venezolana	El Al Israel Airlines
Alitalia	Iberia Spanish Air Lines
Lufthansa	Icelandic Airlines
VARIG	SABENA
	S.A.S.
	Swissair

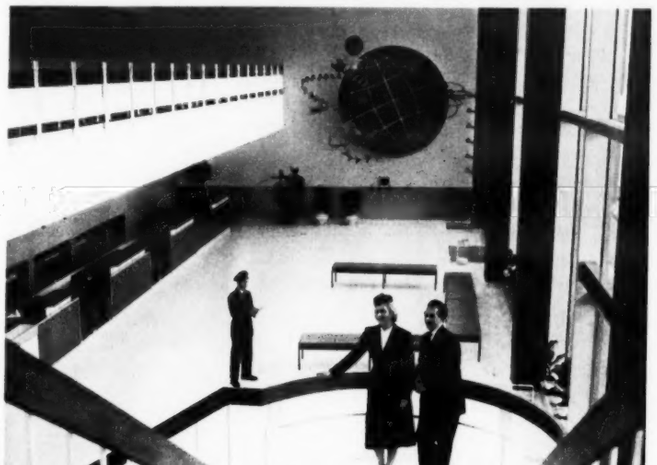
All outgoing passengers will be handled on the higher level in the Airline Wings and, when their flight is called, will proceed to their aircraft by way of the upper level of the fully enclosed arcades. Each airline has been provided with the space necessary to meet its particular requirements and each carrier has been given the opportunity for individual design preferences.

*

When completed in 1960 the Terminal City will include an individual terminal building for each of the major U.S. flag carriers with provision for 140 aircraft positions, an operations building, ten miles of roadway, seven miles of taxiways and parking space for 6,000 cars in a landscaped park with pools and fountains. In all, 36 airlines, representing 23 nations, will share the use of the Terminal City buildings to serve the 11,100,000 passengers a year expected by 1965.



Two views of Air France's passenger terminal in the west Airlines Wing at Idlewild. Left, mosaic panels in the Parisian Room first-class lounge refreshment bar. Right, shields of the French provinces in the Lafayette Room tourist lounge.



K.L.M. Royal Dutch Airlines passenger hall in the east Airlines Wing. The colour scheme is in traditional K.L.M. silver-grey and blue, with accents of yellow and red.

South-easterly view of the eleven-storey Control Tower at Idlewild with the new Arrivals Building and Airlines Wings behind.

What's in the Air?

Extracts from Interavia Air Letter, *daily international news digest, in English, French and German. All rights reserved.*

AIR TRANSPORTATION

● **Qantas Empire Airways Ltd.** will inaugurate on January 14th around-the-world services from Melbourne to London via San Francisco and New York, returning to Melbourne via the Middle East. With the introduction of this service the Qantas route mileage is increased to more than 72,000 miles. The company has taken out options on six Lockheed *Electras*, with delivery dates from late 1959 to mid-1960.

● **Aeroflot** has been operating since December 6th a twice-weekly service between Moscow and Copenhagen in pool with Scandinavian Airlines System. The route is flown on Tuesdays by S.A.S. with the DC-6, on Fridays by Aeroflot with the Tu-104. According to Marshal Zhigarev, Director General of Civil Aviation, the inauguration of non-stop services from Moscow to Paris, Amsterdam and New Delhi is also in preparation.

● **New York Airways** is considering replacing its present fleet of single-rotor helicopters (Sikorsky S-58 and Sikorsky S-55) with a tandem-rotor Vertol 44-B model, which would carry 15 passengers. The airline is considering the purchase of five Vertol aircraft, possibly to be placed in service next spring.

● **Union Aéromaritime de Transport** is planning to increase the area of its workshop installations at Le Bourget by the addition of a new hangar of 204,000 sq. ft. which will be used exclusively for the maintenance of the Douglas DC-8 jet aircraft ordered by the company. U.A.T. will not only deal with the maintenance of its own equipment but also undertake work for the French Air Force, Fleet Air Arm, flight test centres and foreign companies.

INDUSTRY

● **France's Alouette II jet helicopter** is now on sale on the American market, and first deliveries will be made in January 1958. According to the conditions of the licence agreement between Sud-Aviation and Republic Aircraft Corporation, all the components and the engine are initially to be manufactured in France, while assembly and flight testing will be carried out at Republic's main plant at Farmingdale, Long Island, N. Y. Republic also acquires exclusive production and sales rights for the *Alouette* in the United States and Canada, and the company will ultimately build the helicopter, after an intermediate period. Republic has recently set up a helicopter division, with Herbert H. Munsey as Manager; it will also provide sales and maintenance service in the United States.

Fiat is to build the Bristol *Orpheus* engine under licence in Italy. Picture shows, left, Professor Valletta, President and Managing Director of Fiat, and right, Sir W. Reginald Verdon Smith, President and Managing Director of Bristol, after signing the agreement.

West Germany's Defence Minister Franz Josef Strauss visited the Fiat plant early in December and had the Fiat G.91 light strike fighter demonstrated to him at Caselle airfield. Back to camera is Fiat Chief Test Pilot Simeone Marsan.

General Ferdinando Raffaelli, Chief of the Italian Air Staff, inspecting the range remaining indicator developed by Ottico Meccanica Italiana & Rilevamenti Aerofotogrammetrici and seen here fitted in the cockpit of a Fiat G.82.

● **De Havilland Aircraft of Australia**, according to rumours in Australia, plans to put a 4—5 seat tourer and executive-type aircraft into production in the Commonwealth. The story has not yet been confirmed officially.

● **A Chance Vought F-101A Voodoo** of the U.S. Air Force and piloted by Major Adrian Drew, has set up a new world air speed record of 1,207.6 m.p.h. The previous record was 1,132 m.p.h. and was held by Peter Twiss in a Fairey Delta FD-2.

AIRCRAFT AND POWERPLANT

● First details of the *Boeing 720* are available from an announcement by United Air Lines, which has recently placed an initial order for eleven of these aircraft. According to the U.A.L. statement, the Boeing 720

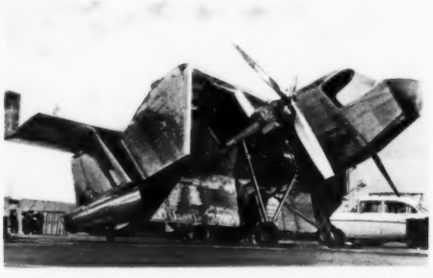
The Lockheed *Electra* fitted with four Allison turboprops and offering accommodation for 66 to 91 passengers, on its first public demonstration.

Another debutante for the jet age: the first civil Boeing 707 being prepared for its maiden flight.

North American F-107A supersonic fighter, with air intakes on top of the fuselage.

First flight of Britain's Fairey *Rotodyne* helicopter for 48 passengers; speed in level flight 170 knots.

Slender 17 ½-ft. auxiliary fuel tanks (capacity 200 U.S. gallons) will be used to extend the Lockheed F-104A's range on special missions.



Ryan *Vertiplane*, a new experimental VTO aircraft for the U.S. Army with large-area wing flaps to deflect the slipstream downwards. The aircraft takes off and flies in the normal horizontal altitude, and its two propellers are driven by a Lycoming T53 turbine.

New York City (with Brooklyn Bridge in the foreground) photographed by a U.S. Air Force RF-101 *Voodoo* from 10,000 feet, during a record flight Los Angeles – New York – Los Angeles.

will be capable of cruising speeds in excess of 520 knots and will have a cabin layout for 100 to 125 passengers. Span 130 ft. 4 ins.; length 134 ft. 6 ins.; payload 31,000 lb.; maximum take-off weight 203,000 lb.; cruising altitude between 25,000 and 40,000 ft.

● The *Boeing IM-99 Bomarc* interceptor missile has a range of more than 250 miles, according to a military spokesman. It has also been announced that Boeing is working on an advanced model of the *Bomarc*, to be powered exclusively by solid propellant rocket motors, thus "simplifying logistics and minimizing reaction time".

● It is rumoured that the airframe for the *Northrop N-156F* lightweight supersonic fighter, designed for N.A.T.O. use, might be assembled in Europe. Engine type has not yet been selected, but may be one of several European jets. The N-156F will reportedly have a gross weight of only 10,000 lb., but still have the performance of the Century Series of fighters. Its armament will probably consist entirely of air-to-air rockets, specially suitable for use against enemy intruder aircraft and certain guided missiles. Span 20 to 25 ft., length approximately 40 ft., range nearly 1,000 nautical miles.

● The armament for the *Dassault Super Mystère B.2* single-seat strike fighter has now been officially announced. In its fuselage the B.2 carries two DEFA 30-mm cannon with a rate of fire of 1,200 rounds per minute at a shell muzzle velocity of 3,280 ft/sec, plus 35 rockets in a container, which can be replaced by an auxiliary fuel tank. External loads comprise 38 rockets in two honeycomb containers, or two 1,100-lb. bombs, or two napalm containers, or 12 heavy, hollow-charge rockets, or air-to-air missiles, or finally two jettisonable fuel tanks.

● The *MD. 12 four-engine feeder aircraft* is reported to have been ordered by the Polish airline LOT. The quantity concerned is not stated. The MD. 12, powered by four 7-cylinder Narkiewicz WN-3 radial engines each with a take-off rating of 340 hp at 2,500 r.p.m., should be ready for test flights in the first half of 1958.

● A lightweight jet trainer, designated *TS-11 Iskra* is at present under development at the Polish State Factory. The aircraft, which has been designed by Engineer Tadeusz Soltyk, is also to be supplied to civil aero clubs to familiarize sports pilots with the peculiarities of jet propulsion. TS-11 is a two-seater with a small Polish-designed jet engine and conventional airframe structure. The engine is said to develop a thrust of several hundred kilogrammes and give the trainer a speed of 527 m.p.h. and a service ceiling of 36,000 ft. The first flight is planned for 1960.

● *New helicopter:* The completion of a prototype of a small helicopter with pulse-jet propulsion, the *CK-1 Trzmiel* (Bumblebee), has been announced. Two pulse-jets of 4.85 lbs. thrust each are fitted at the tips of the two-blade rotor. Other data: main rotor diameter 22.96 ft.; height 7.7 ft.; weight empty 660 lbs.

● In an address to the East German Engineering Chamber, Deputy Prime Minister Fritz Selbmann announced that the first East German *Type 152 jet commercial transport* is scheduled for completion as a test model in 1958, and that quantity production will begin during the second Five Year Plan. By 1960 development of a new, larger jet aircraft, the Type 153, is also to be completed.

● A special version of the *Atar jet engine* for flight at very low altitudes has been tested by SNECMA under the N.A.T.O. strike fighter programme. The engine concerned is reported to be an *Atar E4* with a special fuel metering device and known as the *Atar E4A*. Specific fuel consumption of this model in cruise at low altitudes is said to be 8 % lower than that of the standard E4 version.

● *Gyron Junior DGJ.10* is the designation of a new version of the turbojet engine produced by de Havilland. Thrust has not been announced, but it is believed to be higher than that of the DGJ.1 version which has a thrust of 7,000 lbs.

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Operators have already chosen Britannias for a remarkable variety of stage lengths, from 200-mile inter-city routes to 4,500-mile trans-polar flights. Britannias will be flown between Mexico City and New York by Aeronaves; between Havana and New York by Cubana; between New York and Washington and New York–Miami by Northeast.

The same type of aircraft will be flown non-stop across the Atlantic by BOAC and El Al, and on trans-polar and trans-Pacific routes by Canadian Pacific.

Powered by four 4,120-hp Bristol Proteus turboprop engines, the Whispering Giant cruises at 400 mph, carries up to 133 passengers and cuts operating expenses to a new minimum.

For many months now the Bristol Britannia has been in service throughout half the world. Britannias have been delivered to BOAC, Aeronaves de Mexico and El Al Israel Airlines, and have been ordered by Canadian Pacific, Cubana de Aviacion, Hunting-Clan Air Transport, Ministry of Supply, Northeast Airlines and the Royal Air Force.

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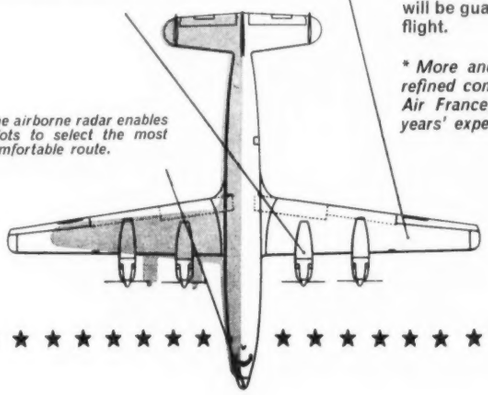

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EFFICIENT AIRLINES are thinking more and more in terms of propeller turbine propulsion for short and medium haul services. In this field the Napier Eland has a number of outstanding advantages, among them being its extremely low maintenance costs.

CHEAPER ON THE GROUND

The Eland engine consists of four main sub-assemblies: reduction gear, compressor, combustion chambers and turbine. Each sub-assembly is a self-contained unit that can be removed and tested separately. This type of construction makes for easier and quicker maintenance and gets the maximum working life from each component.

CHEAPER IN THE AIR

The Eland is designed for economy. A Convair with piston engines will carry a full payload 250 miles, but the same aircraft, after conversion to Eland engines, is able to extend its range to 970 miles and increase its speed by 55 m.p.h. The extra 2,000 h.p. that is developed by the Elands enables the same aircraft to carry its full payload under operating conditions of extreme temperatures and altitudes. This economy and flexibility can be expressed in substantially lower operating costs.

PASSENGER APPEAL

Passengers need no technical knowledge of aircraft to form stubborn preferences. Once they have experienced (or been told about) the smoothness and quietness of turbo prop flight, they will avoid travelling by piston engined aircraft whenever possible. In addition, the greater simplicity and reliability of the turbo prop engine are factors that weigh heavily with the passenger and influence his choice of airline.

TO BUY OR CONVERT?

While the final decision depends on a number of variables—such as the life of the aircraft, its book value and its revenue earning power—it is almost always sounder economics to convert an existing piston engined machine than to buy a new airliner. An Eland conversion can be carried out for less than a third of the cost of a new aircraft with the certainty that this expenditure will be quickly recovered by the increased earning power.

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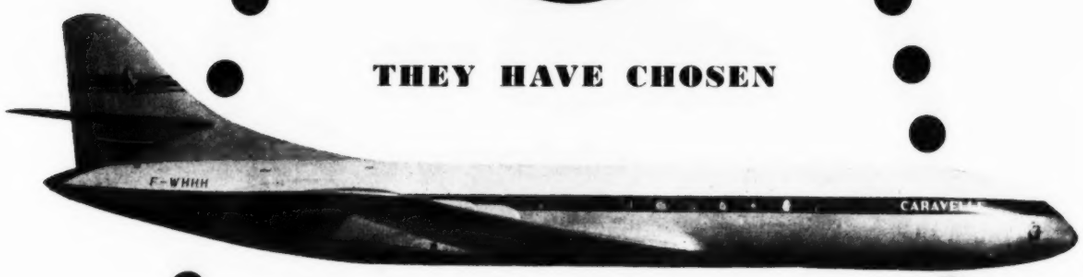

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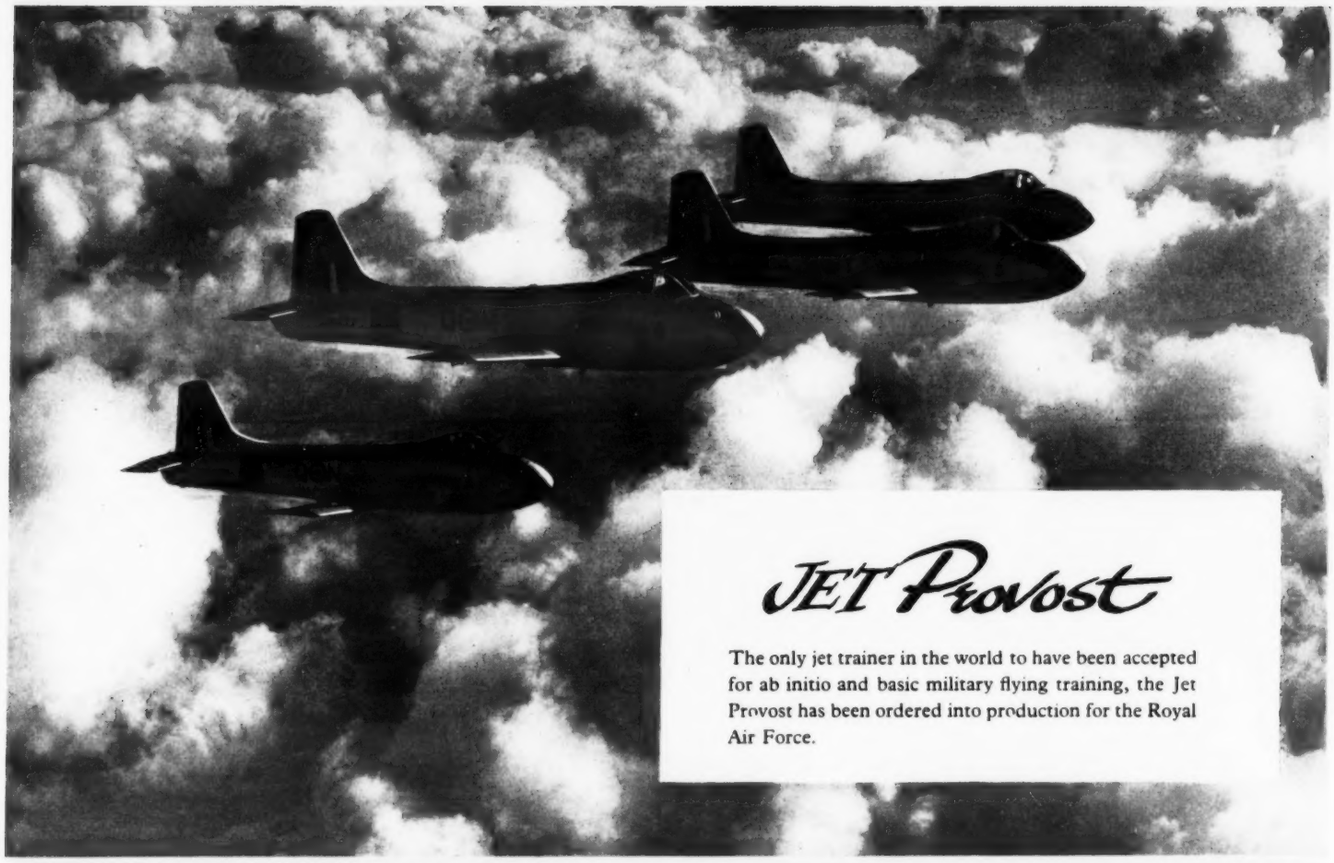

JET Provost

The only jet trainer in the world to have been accepted for ab initio and basic military flying training, the Jet Provost has been ordered into production for the Royal Air Force.

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In service with the Air Forces of seven nations, the Pembroke is a versatile general purpose military transport. Passenger seats are quickly removable for conversion to the roles of freight carrying, supply dropping, ambulance, aerial survey or flying classroom.

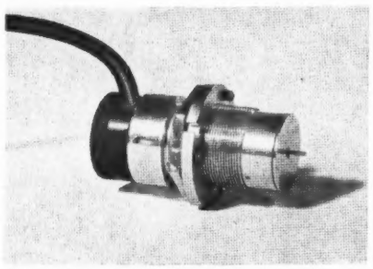
Telecommunications and Electronics

In view of the growing importance of telecommunications and electronic aids in all branches of aviation, the "Equipment Round-Up" feature will in future be divided into two sections: "Telecommunications and Electronics", and "Recent Products of the Equipment Industry".

● **A mobile UHF transhorizon communication terminal,** transportable by air, has been developed by Collins Radio Company, and is at present being evaluated at the U.S. Army Electronic Proving Ground at Fort Huachuca, Arizona.

The complete terminal, packed in two metal containers which serve as huts when the station is erected, can be easily carried in such transport aircraft as the C-119 or C-124 or by truck, and offers the highest degree of mobility available today.

The terminal, employing tropospheric scatter propagation, operates in the 1,000 Mc/s band, and offers extremely reliable multi-channel communication over ranges of 50 to 100 miles without intermediate relays. Two inflatable 15 ft. parabolic reflector antennas are utilized ; each reflector consists of two vinyl-coated plastic sections clamped to a ring girder hoop to form an enclosed envelope ; the inside surface of the rear section is coated with aluminium and a protective mylar film, and serves as the reflector, while the front section is transparent to RF energy. Inflation time is approximately 12 minutes, and the antenna is designed to withstand winds up to 70 m.p.h. without distortion. The complete antenna assembly, including tower, weighs approximately 400 lb., and when dismantled occupies a storage space 3 ft. × 2 ft. × 7 1/2 ft.



● **Philips** is manufacturing the illustrated PR 9310 (GM 5537) inductive amplitude sensing unit which, employed in conjunction with the PR 9300 (GM 5536) measuring bridge, can be utilized to measure relative movements of up to 1 mm, of both static and dynamic nature.

The sensing unit functions on the variable coupling principle. An iron core attached to the sensing pin can move longitudinally inside a small non-magnetic tube, carrying three coils. The pin, mounted between two thin leaf springs, protrudes from the steel housing. The centre (primary) coil is fed with a carrier-frequency voltage from the measuring bridge and induces a voltage in the two secondary coils, dependent on the position of the iron core, and thus of the sensing pin. Values are measured by the position of the iron core in relation to the electrical centre of the coil system and presented by needle deflections on the measuring bridge, or by oscillograph.

● **The new Lear Integrated Flight System,** illustrated herewith, provides in simplified form all necessary attitude, heading, flight path and director information required. The system comprises two pictorial indicators — the "Nafli" (natural flight indicator) Computer and the Course Indicator—which receive intelligence from the Master Gyro Reference and a transistorized flight director computer.

The Nafli Computer (*top picture*) is an integrated, 3-axis attitude indicator and flight director, which displays command director information indicating required pitch and/or roll by means of a miniature moving airplane symbol, seen from a tail view. A rotating directional gyro azimuth card indicates heading. If the pilot wishes to turn to a pre-selected heading, he banks towards the desired heading and rolls out on the pre-set heading pointer. Glide slope pointers, shaped like wing-tip tanks, supply command signals for intercepting and holding glide slope.

The Course Indicator (*lower picture*) is a horizontal situation display which gives aircraft magnetic heading and position in relation to VOR or localizer beam.

Thus, while the Nafli Computer presents a continuous picture of aircraft attitude, the Course Indicator provides a "plan-view" of present situation and future course with respect to radio and compass navigational inputs.

1 : *Heading select knob*, positions heading index (4) and feeds heading signal to computer.
2 : *Computer pitch command signals*. In ILS mode, diamonds indicate glide slope displacement and supply correction command signals.
3 : *Aircraft attitude reference*, follows climb and roll of the aircraft (as seen from behind).
4 : *Desired heading index*, set on azimuth card by heading select knob (1) and rides with azimuth card as reference pointer.
5 : *Computer bank command index*, controlled by the computer.
6 : *Aircraft bank index*, indicates roll attitude.
7 : *Heading card, servo driven.*
8 : *Level pitch references.*
9 : *Level roll reference marks.*
10 : *Pitch trim knob*, for centring the pictorial aircraft within ± 5°.
11 : *Pitch command reference dots/glide slope deviation.*
12 : *Gyro warning flag.*
13 : *VOR 'FROM' station arrow.*
14 : *GS warning flag*, indicates weak signals or failure from glide slope receiver.
15 : *Airplane reference*, shows airplane reference to desired course.
16 : *VOR 'TO' station arrow.*
17 : *Course arrow index*, indicates selected VOR radial or localizer course.
18 : *Heading index or lubber line*, etched on dial glass ; rotating azimuth card displays magnetic heading.
19 : *Heading card*, servo driven repeats magnetically slaved directional gyro information.
20 : *Course displacement bar*, represents lateral course deviation.
21 : *Course deviation dots.*
22 : *Glide slope deviation bar*, represents position of glide slope with reference to the aircraft.
23 : *Glide slope deviation dots.*
24 : *Reciprocal course index.*
25 : *Course setting knob*, positions VOR radial and localizer course arrow (17).
26 : *LOC/VOR warning flag*, indicates weak signal strength from navigation receiver.

● **Decimetre wave forward scatter link between Cuba and Florida** : A forward scatter link working on decimetre waves was recently placed in service between Cuba and Florida for use in the exchange of television programmes. A statement issued by C. Lorenz A.G., Stuttgart-Zuffenhausen, reveals that the link—the first of its kind in the world—took three years and cost roughly $ 3,000,000 to build.

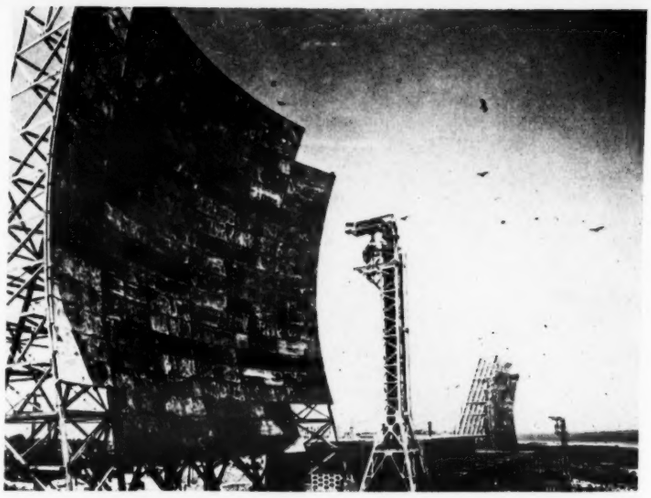
The project was undertaken jointly by International Telephone and Telegraph Corporation and American Telephone and Telegraph Company. The Cuba terminal, at Guanabo, is operated by IT & T through its local subsidiary, while the Florida City terminal is controlled by AT & T. From Florida, the link is tied in with the Bell Telephone System.

Other decimetre links for communications purposes are being built by IT & T between Puerto Rico and the Dominican Republic, and another, linking Sardinia and Minorca in the Mediterranean and forming part of a direct telephone system between Italy and Spain, is already in operation. An extensive system of forward scatter links is being installed for the N.A.T.O. countries ; it will stretch from northern Norway to eastern Turkey. IT & T has also been commissioned to build a system crossing the Straits of Gibraltar, similar to that which has already been put in operation across Alaska and northern Canada.

The link's terminals, at Guanabo and Florida City, are unusual in that their antennas are squares with a side of 60 ft. Each terminal has two antennas, which work on different frequencies. The transmitters have a power of 10 kW, and each station has an emergency power supply for use in the event of a breakdown in the public grid system. Antennas and buildings are hurricane-proof.

The forward scatter link has proved to be an economic system for telephone networks, particularly over oceans, mountains and other regions where no relay stations can be erected. Present communications experience indicates that every new system should incorporate television relay provisions for use in case of need. Federal Communications Laboratories—the research branch of IT & T —has therefore designed and built the new forward scatter link with this in mind.

A 70 Mc/s carrier signal, such as is transmitted by normal broad-band radio links, is passed to the input of the FTL system. Speech channels can be passed to the forward scatter terminal via the usual group converters and decimetre radio links with relay stations. The broad-band forward scatter equipment has a range of up to 300 miles. The receiving station can be connected to the telephone terminal by radio links, cables or other connections. Forward scatter transmission works on a fourfold diversity system, consisting in turn of two dual diversity systems (space and frequency diversity). To provide space diversity two parabolic antennas (60 ft. square) are set up at each terminal. Each station transmits on two different UHF frequencies, both similarly modulated, which produce a frequency diversity transmission. In addition, this provides a complete standby, so that operation is not interrupted if part of the system fails. The system is also divided into two for the simultaneous transmission of television images and speech, each portion working on dual diversity.



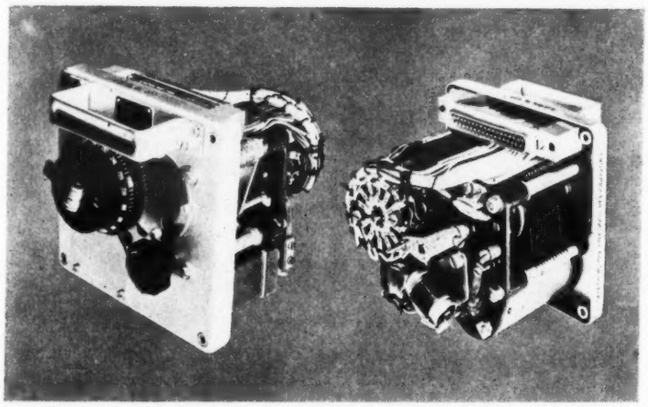
● **I.B.M. France's computer centre :** This year has seen the installation of an I.B.M. 704 Data Processing System at I.B.M. France's Paris Computer Centre, first established in 1949. The system, in the large computer class (of which I.B.M. has set up well over 100 in the United States), comprises 23 functional units electrically linked to the central computer. Each unit has its special function, some serving to read the data, others storing commands for the computing programme or the millions of characters which may be required for the computation. The central computer unit accomplishes the arithmetical and logical operations. The results can be presented by one of four methods : on magnetic tape, printed, punched on cards, or on a television screen.

Some details of the I.B.M. 704 :

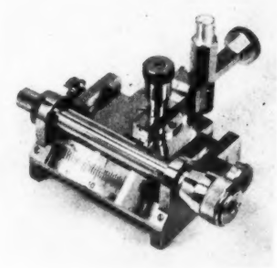
— Reads 90,000 binary characters per second ;
— Performs 42,000 commands per second ;
— A logical resolution available within 24 microseconds ;
— Storage capacity for 200,000,000 binary characters. The results are recorded on magnetic tape at a rate of 90,000 characters per second. They can also be displayed on a television screen ;
— Weight 43 tons ;
— Housed in an air-conditioned room roughly 3,000 sq. ft. in area.

Speed of operation is so great that any problem can be solved many thousands of times more rapidly than by hand. John Napier took 30 years to work out his logarithmic tables. The I.B.M. 704 today can work out the logarithms of every number from 1 to 10,000 to ten digits in 10 seconds, and record the results on magnetic tape in 7 seconds.

To make this highly efficient Data Processing System available to research workers, I.B.M. has offered computing time on the 704 valued at more than a million Swiss francs free of charge for pure scientific work.



● **A new lightweight selector unit,** designated Type 9008, has been developed by Plessey Co. Ltd. in collaboration with the Royal Aircraft Establishment. Remotely controlled, the device rotates and locks a shaft to any one of twelve predetermined positions within one 320° turn. Primary movement is by a relay-controlled electric motor operating from a 48 (±6) volt supply. Selection is by means of a single-pole 12-position switch at the remote operating position. Dimensions : 4 in. × 4 in. × 4½ in. ; weight approximately 2½ lb. At present this unit is being used in UHF transmitter-receivers.



● **Laboratoires R. Derveaux (Bordeaux)** : The SM 08 Standing Wavemeter for a frequency range of 26,500 to 40,000 Mc/s. The probe assembly has a 20 mm travel by means of a micrometer screw, and position can be read with an accuracy of 1/20 mm ; residual VSWR 1.02 ; RG 96 U standard rectangular waveguide ; connection for rectified probe current by UG 625/U co-axial plug.

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REVIEW OF WORLD AVIATION

Profiles from German aviation...

Professor Ernst Heinkel's 70th birthday

The writer wishing to assess Ernst Heinkel's first seven decades runs the risk of attaching to him a label, such as " bomber manufacturer ", " jet fighter pioneer ", " producer of the first rocket aircraft ". True, Heinkel has been all of these . . . but a good deal more besides. The connecting thread running through his whole life is his association with aviation in all its forms. It leads direct from Heinkel the student, who in 1911 suffered eight bone fractures in his first, home-made aircraft, to the large-scale industrialist of 1944 with a labour force of 52,000 and the Ernst Heinkel of 1957 to whom French colleagues have extended a helping hand towards a new start. The following are some of the outstanding dates in Heinkel's life:

Born at Grunbach, Kreis Waiblingen, Württemberg, on January 24th, 1888.
1913: Chief Designer for Albatros, Johannisthal.
1922: Foundation of *Ernst Heinkel Flugzeugwerke*, Warnemünde.
1925: Dr.-Ing. honoris causa of the Stuttgart Institute of Technology.
1931: Construction of catapults for Deutsche Lufthansa's Atlantic mail services.
1932: He 70 *Blitz*—fastest mail aircraft of its day, with eight international records.
1935: He 111—twin-engine commercial transport, later the Luftwaffe's standard bomber.
1938: He 176 rocket aircraft.
1939: *He 178, world's first jet aircraft, with Heinkel He S3B jet engine.*
1940: He 280, twin-jet fighter with Heinkel S8 engines.
1945: Loss of the main plants at Rostock, Oranienburg, Reinickendorf, Waltersdorf and Vienna through dismantling; Jenbach/Tyrol plant requisitioned; Zuffenhausen plant under trusteeship.
1950: Development and production of engines for trucks and small cars, two-wheel scooters, etc. at the Stuttgart-Zuffenhausen plant.
1956: Foundation of Ernst Heinkel Fahrzeugbau GmbH, Speyer, for the production of cabin scooters and aircraft.
1957: Licence production of the French Fouga CM.170R *Magister* jet trainer in cooperation with Messerschmitt A.G., Munich.

Honorary Degree for Professor Leo Brandt

On December 5th, 1957, the Munich Institute of Technology conferred an honorary degree as Doctor of Engineering on Under-Secretary of State Professor Leo Brandt, the German radar specialist, " in recognition of his work in introducing electromagnetic traffic control devices, particularly in the realm of radar ".

As former head of Telefunken's Development Department, Berlin, Brandt led the way to the production of modern radio receivers for mobile stations, ships, and aircraft. Under his leadership the German wartime *Würzburg Riese*, *Lichtenstein* and *Berlin* radar equipments were developed.

Brandt's greatest contribution to German aviation, however, has been his energetic work since the war in the reactivation of German aeronautical research (re-founding of the DVL, etc.) and the expansion of German commercial aviation (Board member of Deutsche Lufthansa).

Born at Bernburg, Anhalt, on November 17th, 1908.
1932: Graduated from the Berlin-Charlottenburg Institute of Technology.
1932-1945: Telefunken Gesellschaft für drahtlose Telegraphie mbH, Berlin.
1946: Board member of Rheinische Bahngesellschaft A.G., Düsseldorf.
1948: Managing Director of Rheinische Bahngesellschaft A.G., Düsseldorf.
1949: Ministerial Director in the North Rhine-Westphalia Ministry of Economics and Transport.
1953: Under-Secretary of State.
1949: Lecturer at the Aachen Institute of Technology.
1953: Honorary Professor, Aachen.
1956: Deputy Chairman of the German Atomic Commission, Bad Godesberg.

The General Electric T58: A Gas Turbine for Helicopters

On the completion of an official 150-hour test by the General Electric T58 helicopter gas turbine, the manufacturers released details of the new engine's structure and performance. Initially the gas turbine is to be fitted, in twin-engine installation, in the Navy's Sikorsky HSS helicopter, which is used for anti-submarine operations and must have an extremely long endurance. The T58 is also under consideration for the Army's Vertol H-21D transport helicopter (also in twin-engine installation), to improve its payload, speed and hovering ceiling still further. Finally, the Navy's single-engine Kaman HU2K multi-purpose helicopter is also to be converted to this engine.

The T58 has a one-piece ten-stage axial compressor with variable inlet guide vanes and variable stator blades in the first three stages. The annular combustion chamber is of the straight-through type, with 16 fuel nozzles mounted on the front of the inner liner. A two-stage high-pressure turbine (26,300 r.p.m.) with short-chord blades and cooled by bleed air from the compressor, is coupled directly by hollow conical shaft to the compressor rotor. The adjacent single-stage low-pressure turbine is mechanically independent of the gas generator, operates nominally at 19,500 r.p.m. and supplies shaft power to the rotor via a reduction gear with integral lubrication. The T58-GE-6 version provides power take-off in any one of three positions (forward or aft); the exhaust also has three positions: vertical (pointing down), 90° left or right.

Technical data

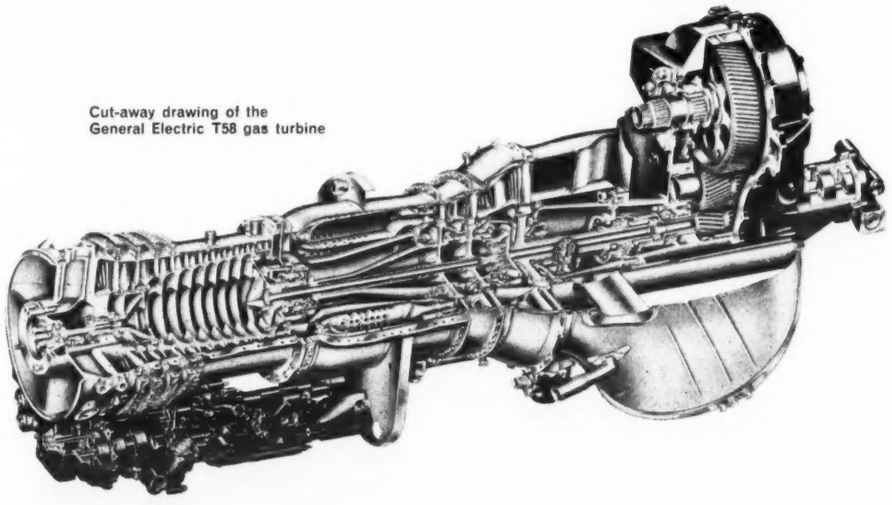
T58-GE-2 version: overall length 59 in., overall diameter 16 in., weight 325 lb., pressure ratio more than 8:1, airflow 12.4 lb./sec., turbine inlet temperature 870°C, military rating 1,024 s.h.p.

T58-GE-6 version: overall length 55 in., overall diameter 16 in., weight 267 lb., pressure ratio more than 8:1, airflow 12.4 lb./sec., turbine inlet temperature 870°C, military rating 1,050 s.h.p.

Results of the official 150-hour test of the T58-GE-2 version:

	Guaranteed		Actual	
	Power s.h.p.	Specific fuel consumption lb./s.h.p./hr.	Power s.h.p.	Specific fuel consumption lb./s.h.p./hr.
Military rating	1,024	0.66	1,065	0.655
Normal rating	875	0.69	920	0.682
90 % normal	787	0.72	828	0.707
75 % normal	656	0.77	690	0.762

Cut-away drawing of the General Electric T58 gas turbine



Book Reviews

Aircraft Engines of the World 1957. — By Paul H. Wilkinson. Published by Paul H. Wilkinson, 734 15th Street N.W., Washington 5, D.C., 1957 (English, 320 pages, 176 illustrations, price $15.).

Like each of its 14 predecessors, this year's edition of the well-known American standard reference book on aircraft powerplants contains a comprehensive survey of the turbine and piston engines available in all countries for aviation use, together with a number of ramjets, rocket motors and gas turbine compressor units. A new addition is a chapter on nuclear powerplants, in which the methods of transferring heat from the reactor to the propulsive unit are described in detail. The open air cycle system and the liquid closed cycle system are illustrated by diagrams. Ri.

Theorie schallnaher Strömungen (Theory of Transonic Flow). — By Dr.-Ing. K. G. Guderley. Springer-Verlag, Berlin-Göttingen-Heidelberg, 1957 (German, XV + 376 pages, 125 illustrations, price DM 42).

Written by an internationally known aerodynamicist—Dr. Guderley worked in Germany up to 1945 and has since been employed at the Wright Air Development Center, in Dayton, Ohio—this comprehensive treatise for the first time attacks, with a wealth of mathematical formulæ, the problems of transonic flow on a broad front. The specialist reader will here find a logically presented account of the region in which both subsonic and supersonic flows appear simultaneously, a region which has been difficult of access by pure theoretical means. The author sets out to show that careful mathematical discussion of the phenomena observed in practice can enable a kind of " insight to be developed which permits extrapolation of results beyond what is precisely known ". He seeks in particular to acquaint the aerodynamicist with the most useful mathematical methods and the mathematician with the questions raised by the physical problems investigated. Ri.

Air Spy. — By Constance Babington-Smith. Published by Harper & Brothers, New York, 1957 (English, 266 pages: 32 illustrations: $4.00). Also to be published in January 1958 by Chatto & Windus, London, under the title: **Evidence in Camera.**

The author, herself a leading interpreter of pictures brought back by R.A.F. reconnaissance aces, relates here the history of Photographic Intelligence both before and during World War II. Her story, which has the pace and dramatic interest of a good suspense novel, provides new behind-the-scene angles on some of the outstanding events of the war in Europe: the *Bismarck* chase, the Commando raids, the Allied bombing offensive, incredibly accurate forecasts of U-boat and aircraft production and the analysis of the V-weapon threat months before the first " Buzz-bomb " appeared over England.

An extremely well told story of equal interest to her 1939-1945 contemporaries and the younger generation. Ru.

III Conferenza Aeronautica Italo-Francese " Leonardo da Vinci ". — Official conference report, issued by the Centro per lo Sviluppo dei Trasporti Aerei, Rome, 1957 (Italian and French, 85 pages, 21 illustrations).

Contains, in addition to the opening addresses by the Italian and French chief delegates, the full text of the two main papers read at the conference: 1—*Louis Lesieux*, Managing Director of Air France, on " Problems of Adapting a Major Airline to the Requirements of Jet Transport ". 2—*Dott. Publio Magini*, head of Società Radio Italiana, on " Air Traffic Control in the European Region after the Introduction of Jet Airliners ". These papers are supplemented by an account of the discussion they aroused. Interesting reading! Ri.

History of German Guided Missiles Development (Agardograph No. 20). — Papers read at the Munich AGARD conference of April 1956, edited by Dr. Th. Benecke and Prof. A. W. Quick, with the assistance of W. Schulz. E. Appelhans & Co., Brunswick, 1957 (English, 420 pages, price DM 32 or $7.50 or 55 shillings).

Anyone who is inclined to relegate the historical development of technical inventions to the museum or the dustiest corners of the State archives will change his ideas after a brief study of this Agardograph. The book is a mine of information, of the highest topical value, for every rocket designer, aerodynamicist and remote-control specialist. Here many World War II weapons, whose parallel developments in West and East are still closely guarded State secrets, are described in detail by the most competent authors . . . one good reason being that these weapons fell into the hands of both Western and Eastern military authorities as " war booty " and are equally well known to both sides. All the authors of the 26 reports are back in responsible positions, some of them in West Germany, others in the United States, Britain, France or Spain. Their names: Th. Benecke, H. A. Wagner, E. Fischel, G. Ernst, H. H. Kurzweg, H. Temme, O. Müller, W. Kloepfer, J. Dantscher, F. Münster, G. Güllner, R. Schäfter, K. H. Schirrmacher, E. W. Kutzscher, F. von Rautenfeld, O. Lütz, H. Vüllers, H. Walter, M. Schilling, H. von Zborowski, Irene Sänger-Bredt, W. Trommsdorff, P. Schmidt, F. Gosslau, W. Wernitz. The English text of the reports, most of which were originally prepared in German, is clear and readily understandable; general presentation and illustration are excellent. Ri.

Dynamische Längsstabilität und Längssteuerung (Volume 12 in the series on Aircraft Design).—By Dr.-Ing. W. Just. Flugtechnik Stuttgart, 1957 (German, 158 pages, price DM 11.30).

Seitenstabilität und Seitensteuerung (Volume **14** in the same series). By Dr.-Ing. W. Just.—Flugtechnik Stuttgart, 1957 (German, 106 pages, price DM 9.20 bound, DM 8.20 paper back).

Written by a well-known German aerodynamicist with long experience in the design offices of leading aircraft manufacturers both in Germany and elsewhere, these two textbooks—like the whole series of which they form a part—are addressed to students at technological institutes and engineers working in industry or at research establishments. The reader, who must, however, have solid mathematical knowledge, is acquainted step by step with the basic mechanical processes of flight and the mathematical methods involved. The price of the volumes in this series is attractively low, in view of their excellent presentation and the amount of work involved in their preparation. Ri.

The Aeroplane Pictorial Review (No. 2). Published by Temple Press Ltd., London, 1957 (English, 64 pages; 10s. 6d.).

Compiled by the staff of " The Aeroplane ", this volume contains a selection of 280 of the most interesting pictures which have been published in that journal over the last twelve months. The illustrations range from the latest types of civil and military aircraft, helicopters and guided missiles to people and events in the headlines during the period. A book of absorbing interest to aviation enthusiasts of all ages. Ru.

Fluglehre - Theorie and Berechnung der Flugzeuge in elementarer Darstellung. — By v. Mises/Hohenemser (sixth revised edition by K. Hohenemser). Springer-Verlag, Berlin-Göttingen-Heidelberg, 1957 (German, 402 pages, price DM 25.50).

The main chapter headings of this textbook—air forces, wing, gliding, propellers, powerplants, performance, control and stability, rotary-wing aircraft, course-setting, flying costs—reveal the subject of this book, which presents a survey of the fundamentals of aviation. As the author of the new edition points out in his foreword, the book is designed to acquaint readers " with no more than average schooling " with the problems of aviation. New sections on compressible flow and drag in supersonic flow, on turbine engines, automatic pilotage etc. have been added. A basic work by a competent author, which also covers recent developments. Re.

Dreidimensionale Überschallprobleme der Gasdynamik. — By Dr. K. R. Dorfner. Springer-Verlag, Berlin-Göttingen-Heidelberg, 1957 (German, VII + 150 pages, 44 illustrations, price DM 26).

Published as Volume 3 in the series " Results of Applied Mathematics ", this report, prepared for the German Research Society and written *for mathematicians*, deals primarily with the flow processes round " flat " bodies in the supersonic range, i.e., round wings of infinite width, discussing them with the aid of " linearization methods ". Ri.

La défense contre l'incendie des aérodromes. — By Major Etienne. Editions S.O.S., Paris, 1957 (French, 228 pages; numerous drawings).

The problem of fire at airports has always been of the utmost importance. The increasing weight of aircraft and hence of the fuel carried necessitates the provision of an increasingly efficient fire-fighting service. Major Etienne's book sets out to show that the organization of a fire service at airports is not only necessary but " paying ", to outline a model administrative system and to describe the equipment to be used, depending on the nature of the airport, the techniques to be used and the internal operation of fire services. The book will be a valuable source of information for the authorities responsible for organizing fire services at airports. So.

Ergänzungsband 1955/57 zum Taschenbuch der Luftfahrt (1954). — By Georg W. Fouchter. J. F. Lehmanns, Munich, 1957 (German, 116 pages, 137 illustrations, price DM 17 linen, DM 14.50 paper).

This supplement to the main aviation handbook, published in 1954 (and reviewed in *Interavia* No. 11, 1954, p. 77), describes—arranged according to countries—the most important aircraft, engines, guided and ballistic missiles brought out during the past three years, in most cases illustrated with appropriate photographs. The list of aircraft and engine manufacturers has also been brought up to date and corrected. Thanks to its handy size and concise presentation, this little book will be a welcome source of general information, though not all the data, particularly on military aircraft, should be accepted blindly. Ri.

Jahrbuch der Luftfahrt 1957. — Edited by K. F. Reuss. Südwestdeutsche Verlaganstalt GmbH, Mannheim, 1957 (German, 530 pages, price DM 12.80).

The 1957 aviation annual contains all relevant details on the legal and organizational basis of aviation in West Germany, on technological institutes, research centres and societies concerned with aviation questions, on air transport, airports and gliding fields, aircraft industry, trade press, sports flying organizations and flying schools. With a final chapter on aviation in Austria and Switzerland, and a list of references and index. Ri.

L'Aérodynamique. — By Jacques Lachnitt. " Que sais-je? " Collection, No. 752, Presses Universitaires de France, Paris, 1957 (French, 119 pages, price 156 francs).

As one of the more recent branches of physical science, aerodynamics has been obliged to follow the development rhythm of the aircraft industry. It has been faced with extremely complex problems, not only in its techniques, but also in the recording and interpretation of results. The object of the present book is to reveal the importance of this branch of research, the magnitude of the efforts made and the results obtained. The author has eliminated all complicated mathematical material and kept his text within the reach of all educated readers. So.

Wörterbuch der Kernenergie: English-German. — Edited by Dipl.-Phys. L. F. Franzen, Dr. L. Hardt and Dipl.-Ing. G. Muszynski. VDI-Verlag GmbH, Düsseldorf, 1957 (English-German, 248 pages; price DM 23.90).

Every German-speaking nuclear physicist, radiologist, nuclear engineer, electronics expert and systems engineer is today more or less obliged to study English and American literature. He will therefore warmly welcome this dictionary of nuclear energy, which includes not only a glossary of terms but also an extremely useful list of English and American abbreviations and conversion tables for units of measure. It will be of real use in the translation and " decoding " of English-language texts. Na.

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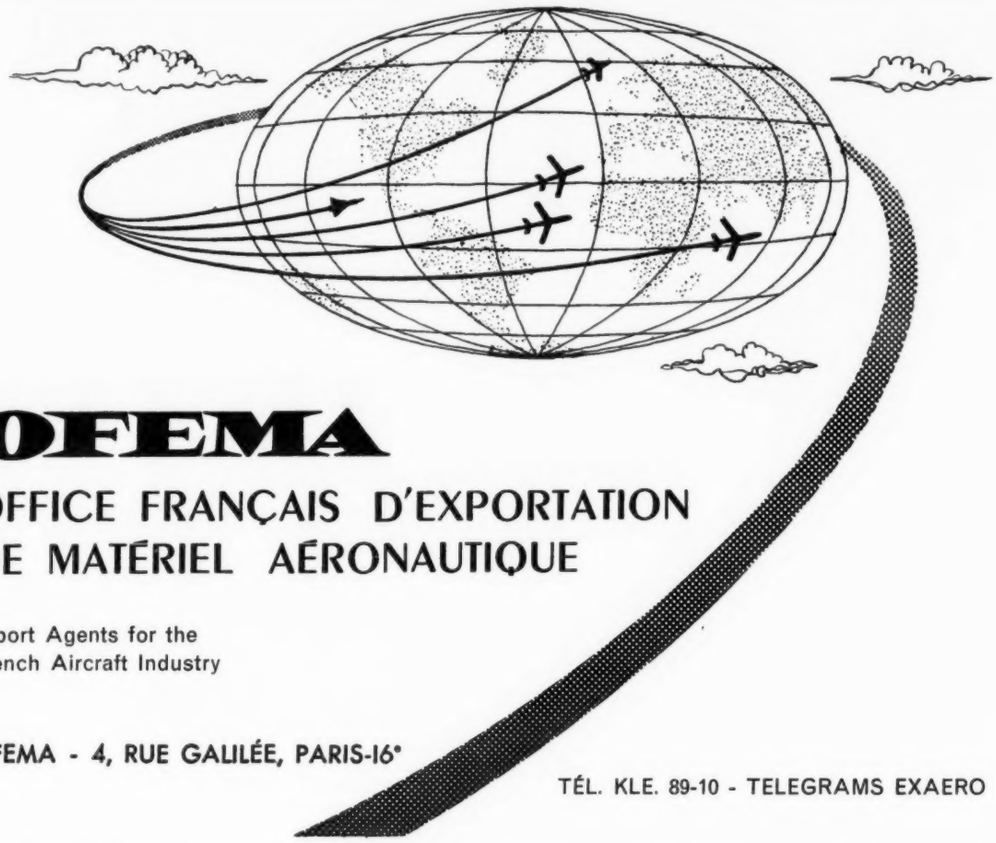

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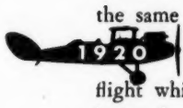
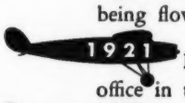
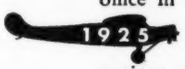


KLM inaugurates the Amsterdam-London flight which is the *oldest* air route in the world still being flown by the same carrier.

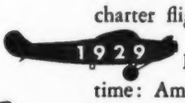


KLM opens the *first* air traffic booking office in the world.

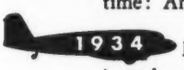


KLM is the *first* to make use of air-cooled engines and all-metal propellers.

1927 - KLM makes the world's *first* intercontinental charter flights.

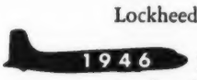


KLM opens the *longest* air route of that time: Amsterdam-Jacarta.



KLM, as the *first* airline outside the U.S.A., introduces all-metal Douglas DC-2 and wins the London-Melbourne Air Race. Two years later KLM is the first European company to buy the DC-3.

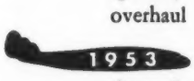
1943 - KLM, as first non-U.S.A. carrier, orders the Lockheed Constellation.



KLM, though heavily shattered by the war, is the *first* European airline to open a post-war North Atlantic service.

1948 - KLM is the first European airline to buy the Convair Liner.

1950 - KLM is the first European airline to be specially authorized by the U.S. Government to overhaul aircraft of U.S. air companies.



KLM is the world's first airline to operate the turbocompounded Lockheed Super Constellation.

1956 - KLM is the *first* carrier outside the U.S.A. to order the jet-engined Douglas DC-8 and the turboprop Lockheed Electra.

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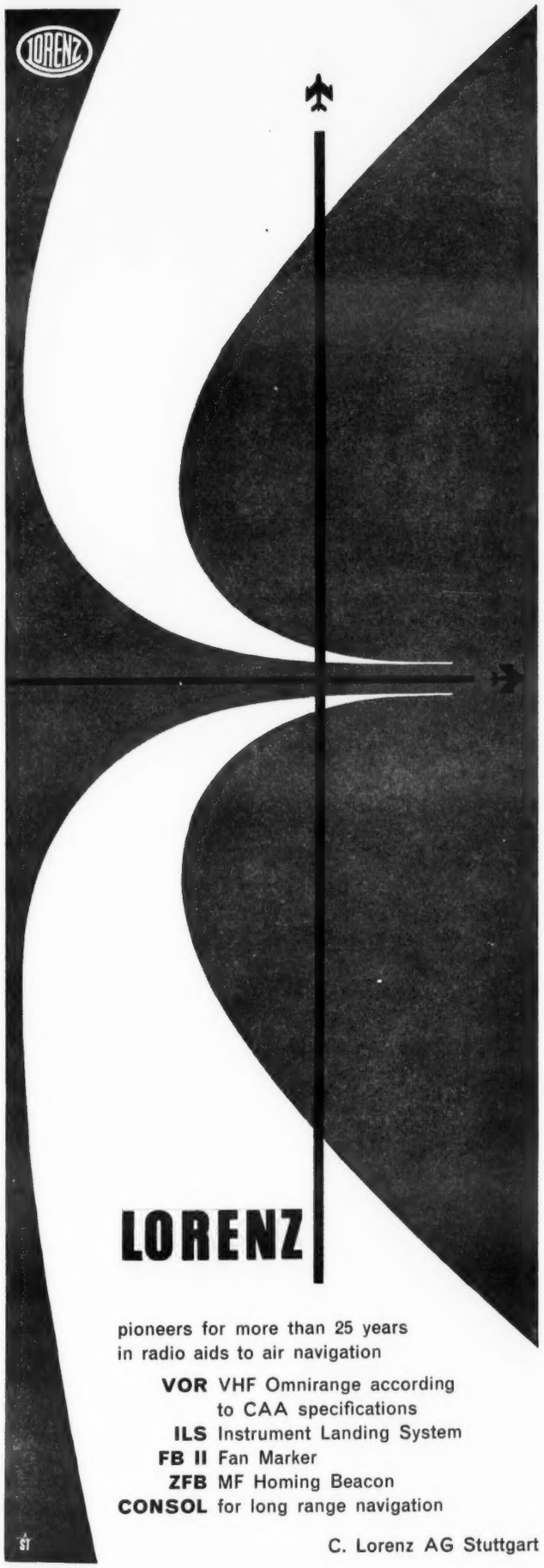

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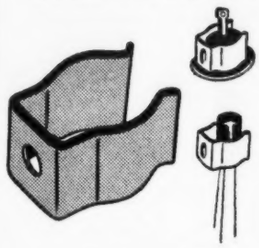

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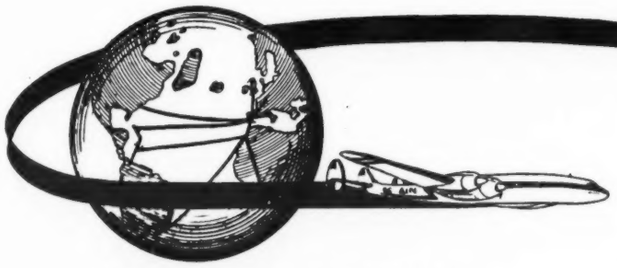

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Iberia

LINEAS AEREAS ESPAÑOLAS

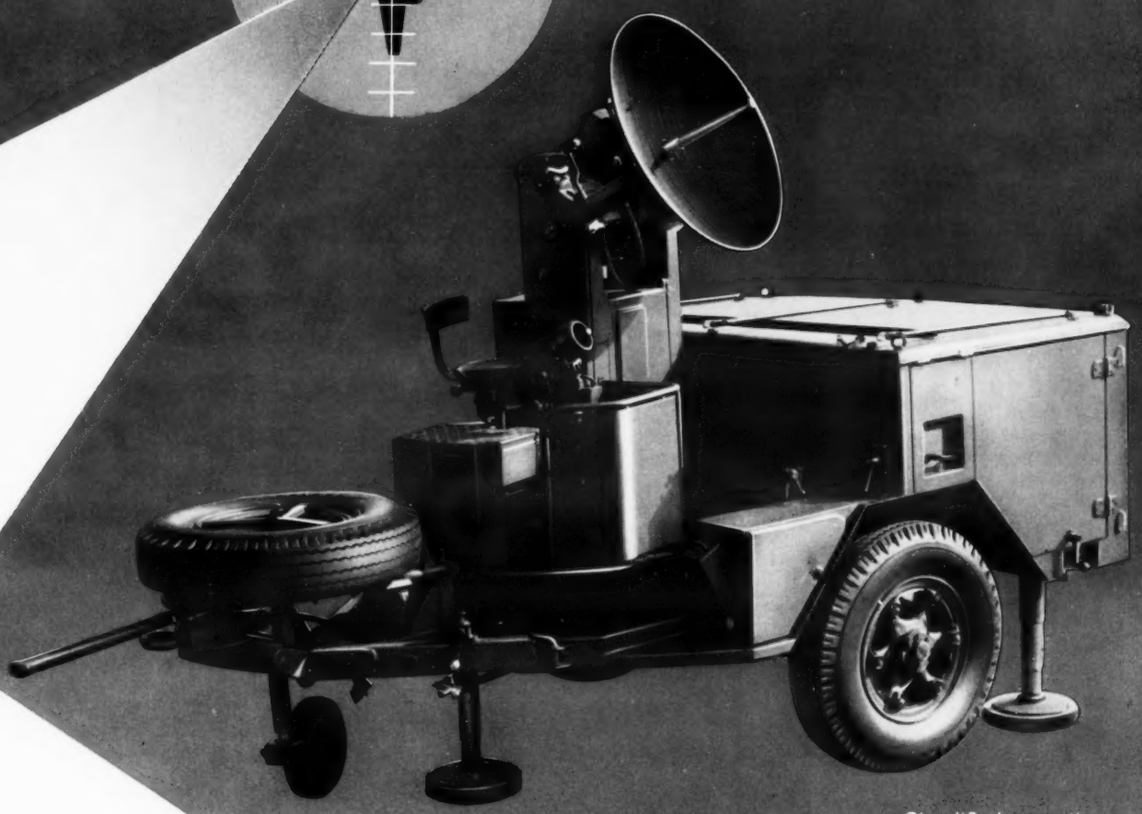
Paper : Papierfabrik Biberist • Cover, four-colour printing and photogravure : Fabag Druck Zurich • Letterpress printing : 755

Printed in Switzerland

GUN FIRE CONTROL SYSTEMS FOR MEDIUM A.A.A BATTERIES

The picture shows a Gun Fire Control System for 40 m/m Guns

consisting of : Fire Control Radar Set for target acquisition and for automatic tracking, optical tracker and electronic computer with a total weight of less than 3 tons.



Simplified operation
High mobility and quick emplacement
Quick computation of gun data with maximum accuracy/Training of maintenance personnel has been simplified considerably through the application, wherever possible, of techniques and components similar to those employed in the design of the Contraves F/90 Director.

CONTRAVES ITALIANA S.p.A. ROMA

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